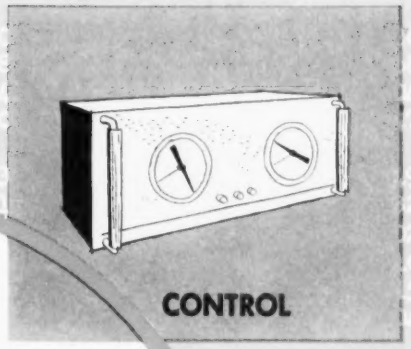
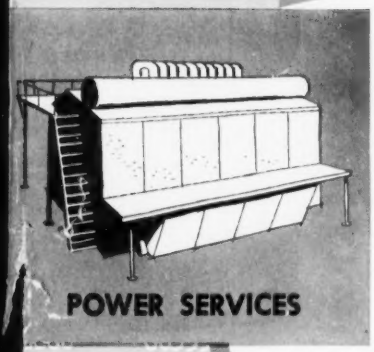
For engineers who design and manage the power and plant services

Power

JANUARY 1958
ONE DOLLAR
A McGRAW-HILL PUBLICATION

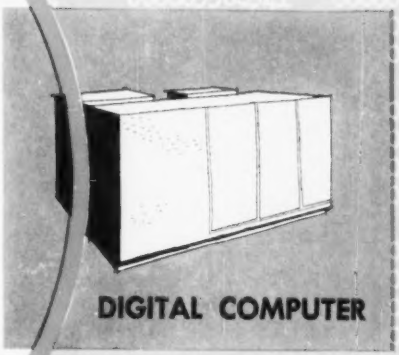


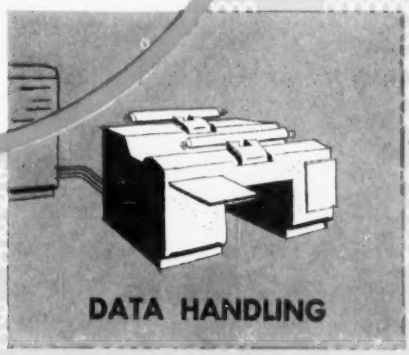


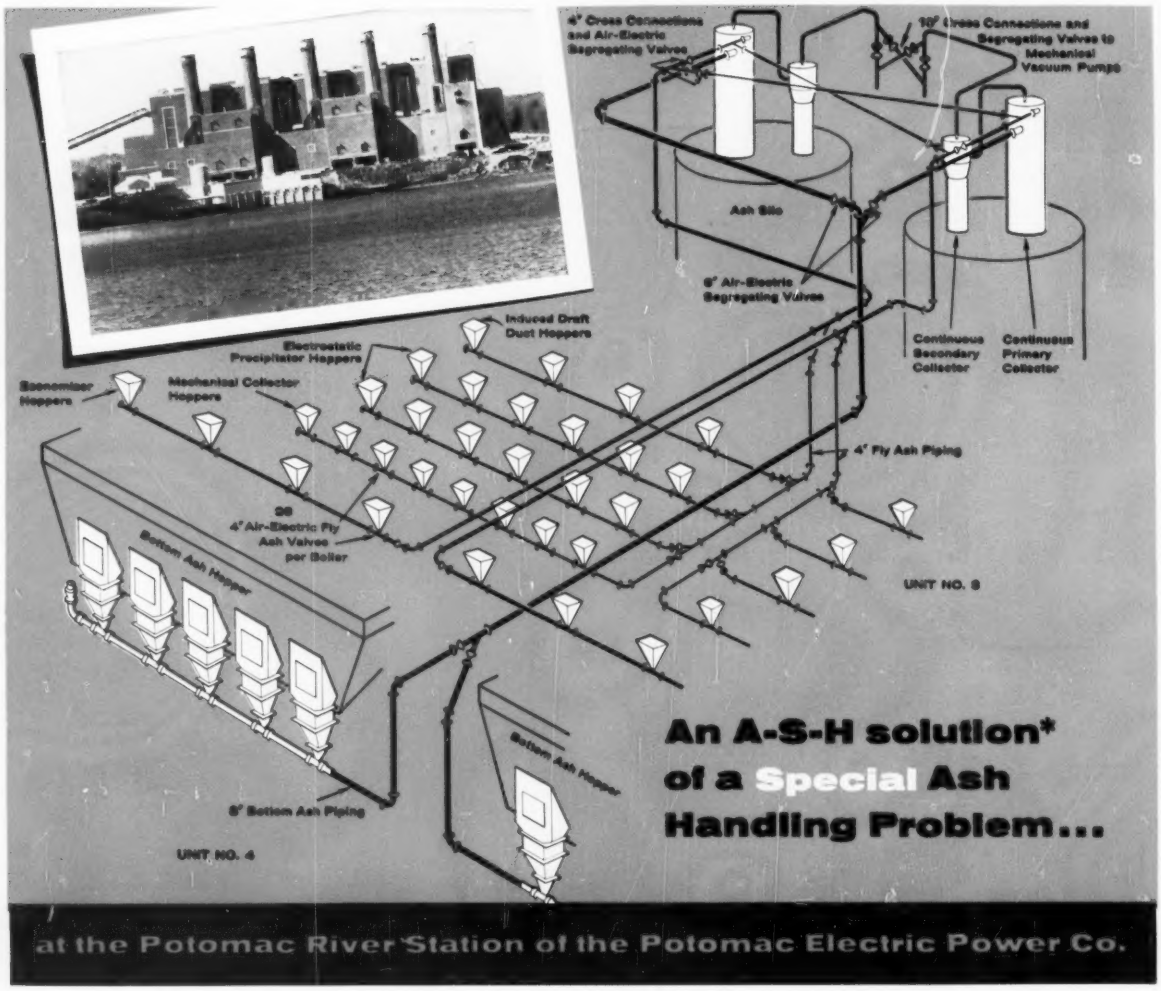
a ***TD*** *report*

Fully automatic digital control —How soon?

see p 71






4" Cross Connections and Air-Electric Segregating Valves
10" Cross Connections and Segregating Valves to Mechanical Vacuum Pumps
Ash Silo
6" Air-Electric Segregating Valves
Induced Draft Duct Hoppers
Electrostatic Precipitator Hoppers
Economizer Hoppers
Mechanical Collector Hoppers
Continuous Secondary Collector
Continuous Primary Collector
4" Fly Ash Piping
36 4" Air-Electric Fly Ash Valves per Boiler
Bottom Ash Hopper
UNIT NO. 5
Bottom Ash Hopper
6" Bottom Ash Piping
UNIT NO. 4
An A-S-H solution* of a Special Ash Handling Problem...
at the Potomac River Station of the Potomac Electric Power Co.

At the Generating Station pictured above, cleanliness is of vital importance. It is located across the Potomac from our Nation's Capital in the popular residential area of many Washington executives and officials in Alexandria, Virginia.

A-S-H Engineers assured cleanliness in ash removal with this versatile, automatically controlled sealed system. Is it successful? As Potomac Electric expanded their facilities to an effective capacity of 493,000 kw, they *added* additional *A-S-H units.*

Notice, in the schematic drawing of two of their five units, how maximum versatility has been achieved. Each steam generating unit has its own ash handling system. But take special notice of the cross connections in the piping, with these advantages:

1. Each unit can operate independently, collecting both fly and bottom ash in its own silo;
2. All ash from both units can be collected in either of the silos alone;
3. Fly ash from both units can be collected in either silo; bottom ash can be collected simultaneously in the other.

The experience that went into the solution of Potomac Electric's problem can be put to work for you. Your "special" problem is not too hard, too big or too small. It is important, to both of us, and we'll give it prompt attention. Describe your problem, and we'll rush you helpful data or arrange for a competent field engineer to call.

* *A-S-H service doesn't stop with installation. When service problems come up, we stand ready to give prompt service assistance. This is a policy worth considering when suppliers are being selected.*

MATERIALS HANDLING SYSTEMS

"Hydrojet" *hydraulic*

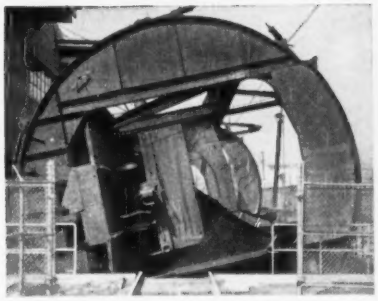
"Hydrovac" *pneumatic*

the **Allen-Sherman-Hoff** company

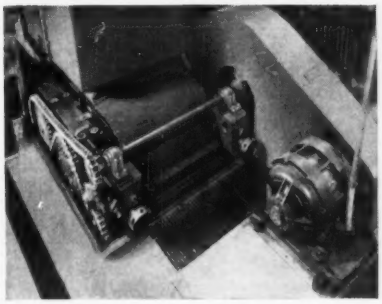
259 E. Lancaster Ave., Wynnewood, Pa.

Offices and representatives in principal cities

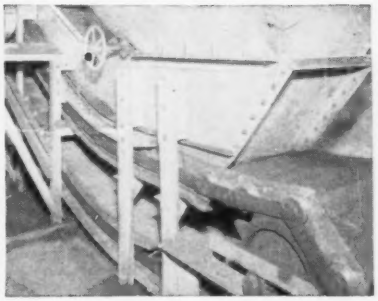
For all sizes of power plants--



ROTARY DUMPERS unload gondola cars in 90 seconds or less (including return to upright position). Handle all types of open-top cars up to 90-ton capacity.



COAL CRUSHERS provide means for crushing run-of-mine coal. Can be furnished in single-roll or two-roll types for producing an accurately sized, uniform product.

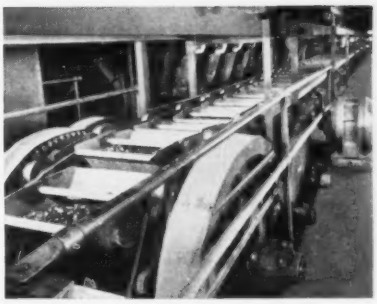


APRON FEEDERS move coal horizontally or on inclines up to 25° from hoppers or bins in continuous, uniform flow. Rugged overlapping pans resist impact.

LINK-BELT equipment and engineering...

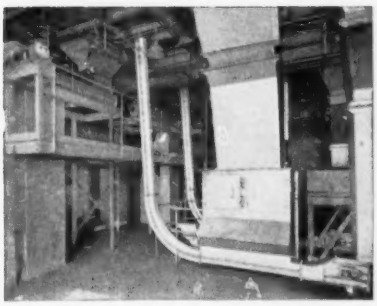
BELT CONVEYORS handle large tonnages at low cost—stock out, reclaim, distribute. Link-Belt also builds all types of idlers, terminal machinery, trippers, etc.

BUCKET ELEVATORS offer flexible, low-cost handling. Link-Belt elevator shown discharges to silo and also handles coal to and from reserve ground storage.

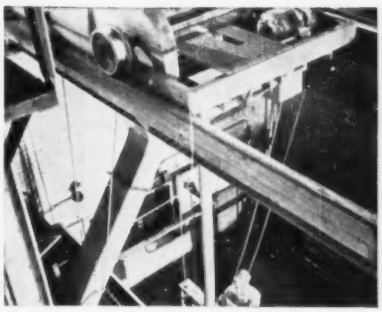


PECK CARRIERS, used in many coal handling systems for the last 60 years, elevate and convey coal in a continuous flow without the need for transfers.

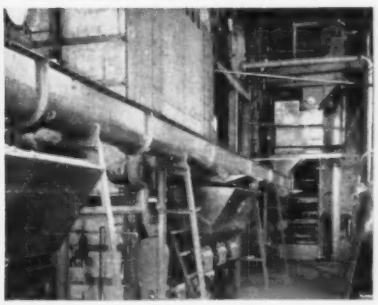
spell lowest per-ton handling costs



BULK-FLO combines functions of conveyor, elevator and feeder in a single unit of high capacity. Above, coal is delivered to crusher for continuous sampling.



WEIGH LARRIES automatically weigh and record amount of coal delivered to each stoker or bunker. Link-Belt offers motor or hand-propelled types in all sizes.



SCREW CONVEYORS provide economical distribution of coal to stoker hoppers. Link-Belt can supply all components—screws, troughs, hangers, drives, etc.

You'll be interested in Book 2410. Its 44 pages of photographs and drawings include many outstanding Link-Belt coal handling systems, large and small. Your nearest Link-Belt office has your copy.

LINK-BELT

COAL HANDLING EQUIPMENT

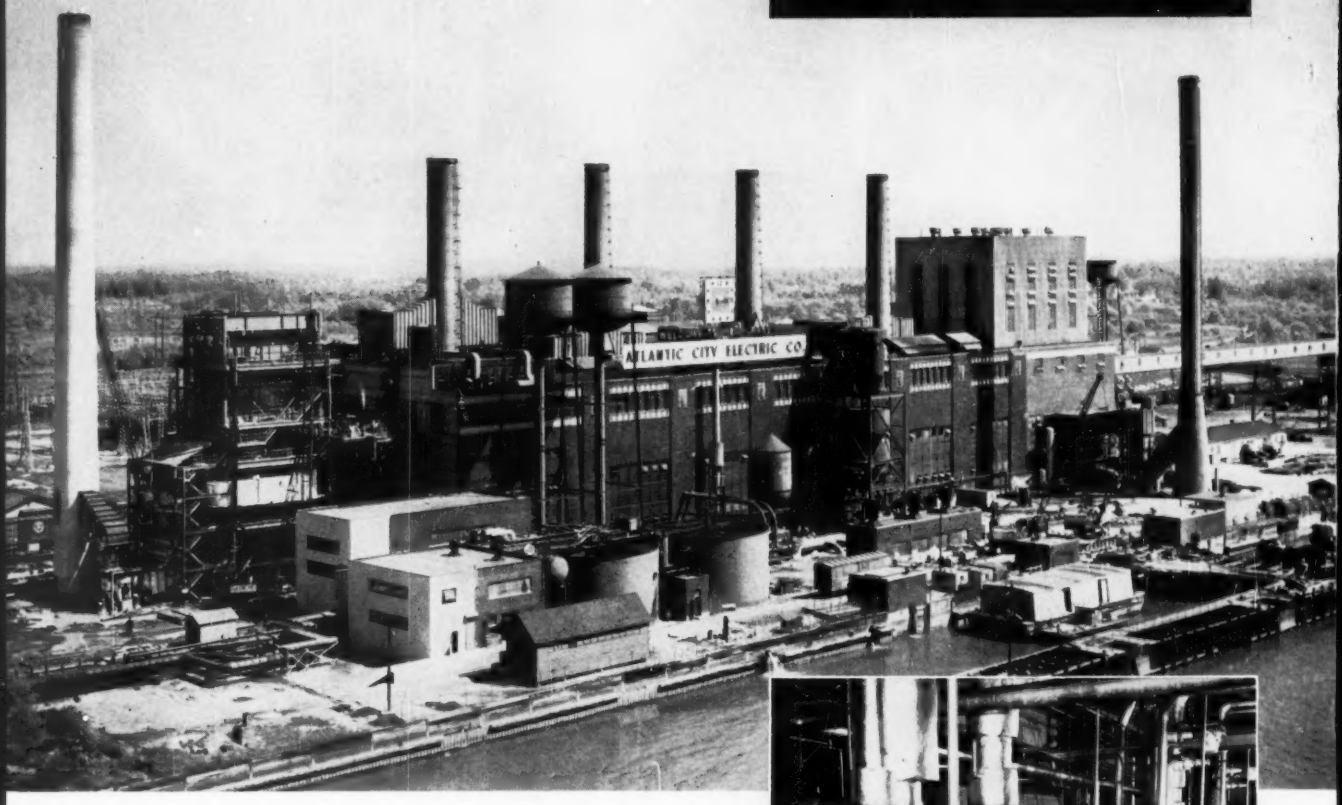
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

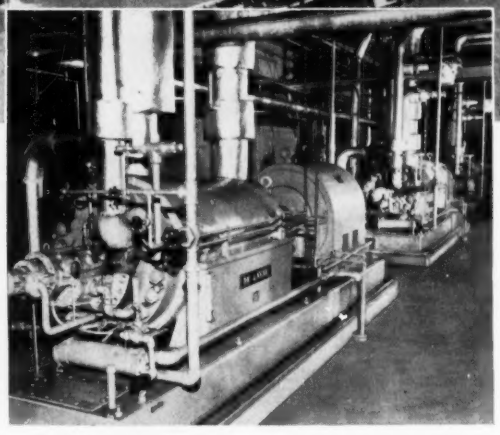
14 227

Modern central stations use

DE LAVAL

BARREL TYPE BOILER FEED PUMPS





Three ten-stage De Laval high pressure, barrel type boiler feed pumps, are on the line at the Deepwater Station of the Atlantic City Electric Company. Shown above is an aerial view of this station located in Penns Grove, New Jersey at the southern end of the Jersey Turnpike. Each pump delivers 675 gpm to the boiler for a total flow of 685,000 pounds per hour. Each pump operates at 1762 psi with temperature at 287 F., and is driven by a 900 hp motor.

When it came time to modernize one of their existing facilities, Atlantic City Electric Company and Gibbs & Hill, Inc., consulting engineers, chose two similar De Laval pumps to serve a new 79,000 kw generator.

IMO Pumps For Fuel Oil Service

Also doing an important job in this Atlantic City Electric Company station are De Laval IMO screw-type positive displacement pumps. They supply fuel oil to the burners round the clock.

Send for De Laval Bulletin 1506, which contains helpful data.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY

815 Nottingham Way, Trenton 2, New Jersey

DL-386

In Power this month

JANUARY 1958 • VOL. 102 • NO. 1 • 76TH YEAR

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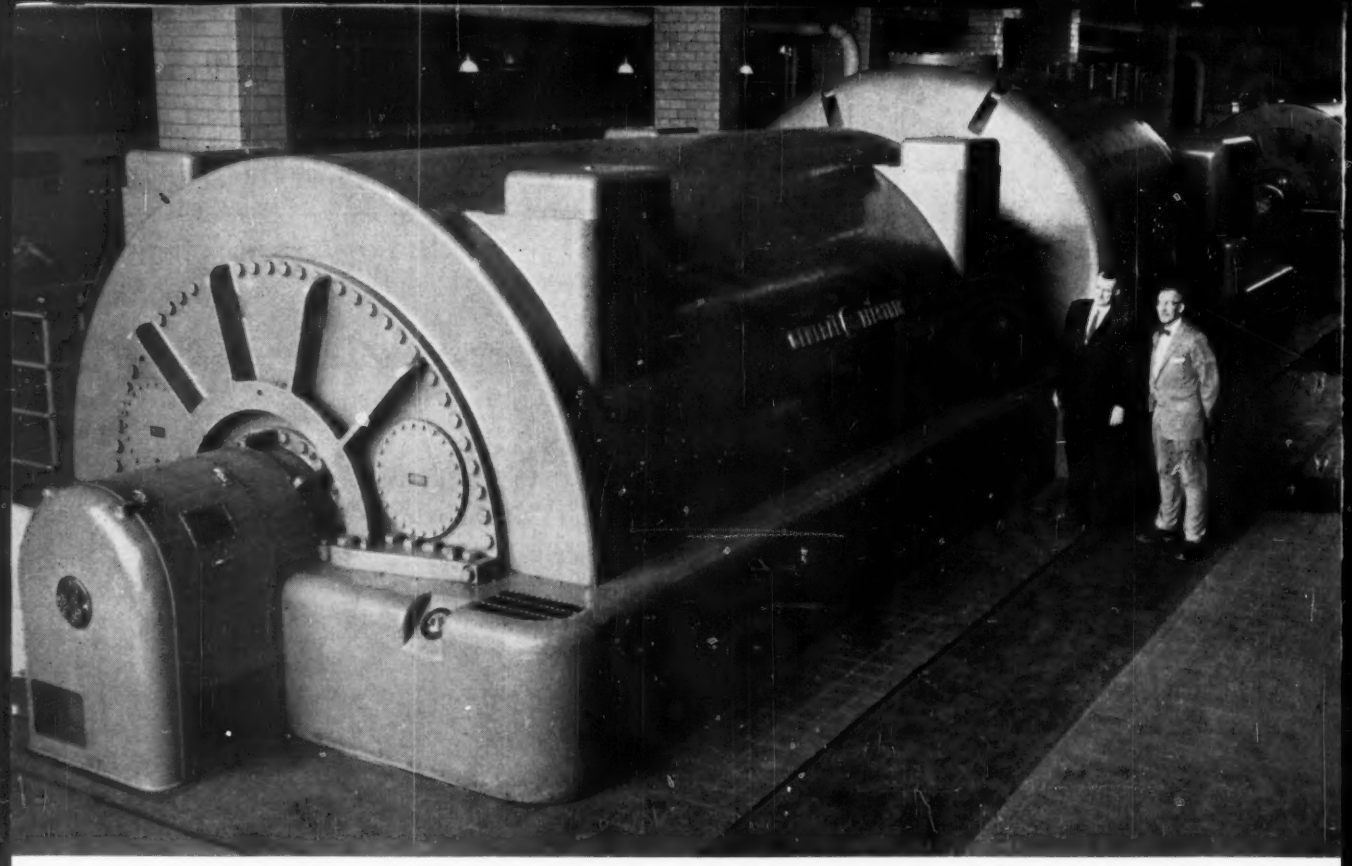

This new 70,000 kw reheat turbine—like all other turbines in this plant—is 100% Texaco-lubricated to keep it free from rust, sludge and foam.

A large Eastern Utility found:

Texaco gives these 3 big benefits for complete turbine protection:

1. Unquestionable dependability. Texaco Regal Oil R&O keeps the utility's turbine system clean; prevents rust, sludge and foam from forming; keeps bearing temperature normal and governor response instantaneous. Texaco dependability is a *fact* for this utility, based on long experience.

2. High efficiency. Texaco Regal Oil R&O assures smooth performance and freedom from unscheduled outages. Texaco Regal Oil R&O gives bearings full protection throughout an extra-long oil service life.

3. Technical service. Texaco offers this important benefit at a time when power demands are almost out-growing turbine production. Past experience in the power plants has proved Texaco Lubrication Engineering Service to be quick and reliable. This service is always available to Texaco customers—whatever the need.

There is a complete line of Texaco Regal Oils R&O to meet the requirements of all leading turbine manufacturers, regardless of turbine type or size. Let a Texaco lubrication expert help you select the Texaco Regal Oil R&O that will keep turbine efficiency high and maintenance costs at a minimum. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States—or write:

The Texas Company, 135 East 42nd Street, New York 17, New York.

TUNE IN... Metropolitan Opera Radio Broadcasts Every Saturday Afternoon

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W K PONDER — *Circulation Manager*

speaking of **Power**

A C Monteith, vice-president in charge of apparatus products for Westinghouse Electric Corp, struck a target close to our heart when he spoke recently before the annual meeting of the National Electrical Manufacturers Assn in Atlantic City. His theme: American factories must "power-up" by boosting capacity of their electrical systems before they can begin to automate in earnest. "What good are all these dreams of automation and increased output if the very energy that is going to make all this possible can't even get in the front door?" We feel these remarks by Mr Monteith are particularly timely and in principle tie in with our current Power to Grow . . . *electrically* (PTG) editorial program.

For the past 18 months, POWER has brought before its readers a series of articles keyed to the pressing need for better planning of industrial electrical distribution facilities. This PTG editorial program will continue to outline the kind of thinking necessary in plant design and equipment selection to meet the burgeoning electrical demand. And one mighty important phase of the industrial electrical scheme is protection; protection as viewed from the angle of guarding people, machines and production quotas from damage caused by overloads and short circuits.

It was this that prompted the article on short-circuit calculations, p 97. Aimed to take the grind out of short-circuit figuring, the article serves to pinpoint the first lap in the complete electrical design operation.

One omission in our 75th anniversary issue (Sept 1957) is a matter of deep regret to us—the fact that Cochrane Corp was not included in the list of companies advertising in POWER for 35 years or more. Actually, as mentioned with pride in the Cochrane ad, pp B 238-239, they have told their product story in POWER for more than 60 years. For many years this program was in the name of a predecessor company—Harrison Safety Boiler Works. Our researchers missed that company's connection with Cochrane Corp and lost an opportunity to acknowledge a long and pleasant association.

Lou Rowley

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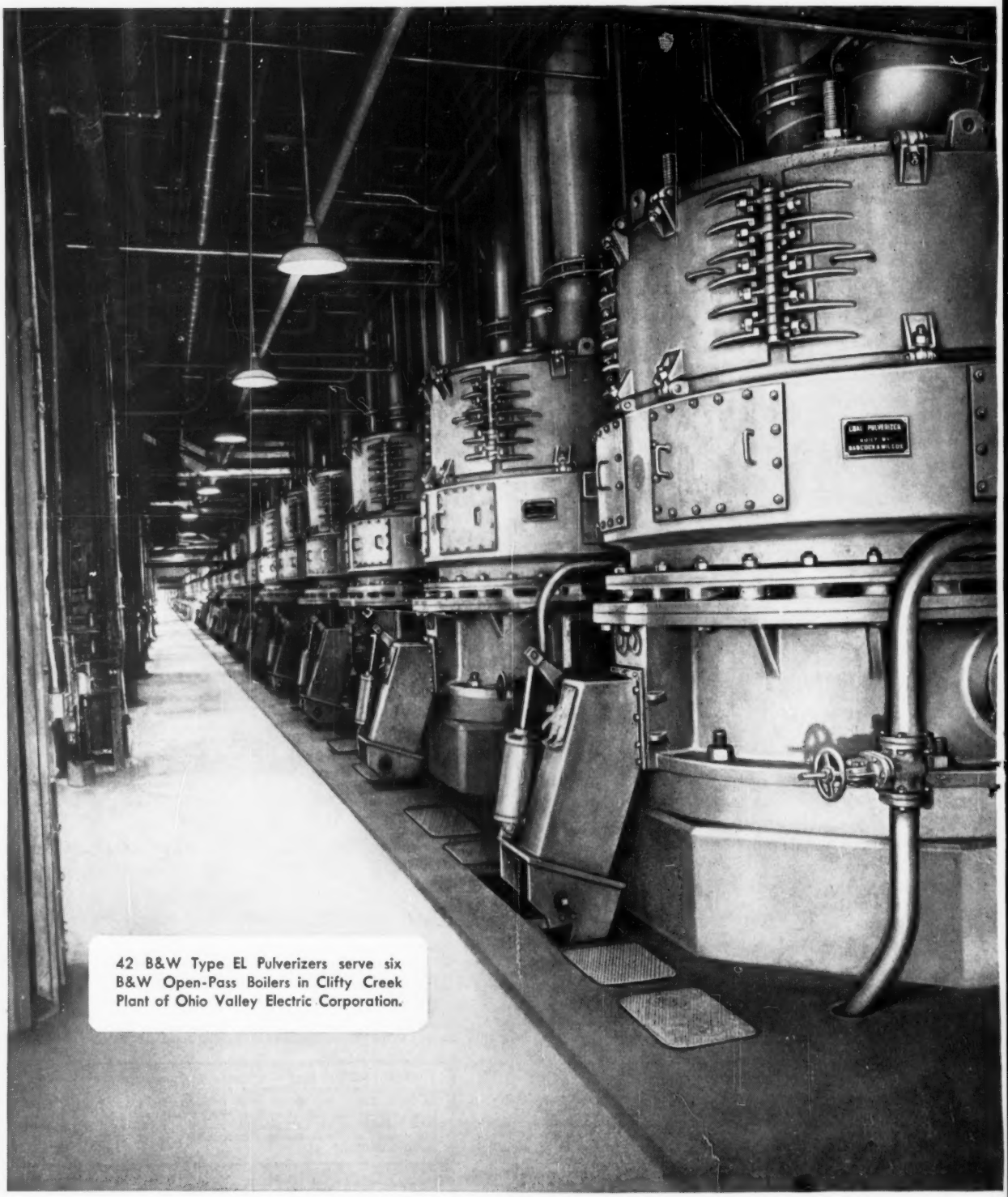
THE MODERN B&W



42 B&W Type EL Pulverizers serve six B&W Open-Pass Boilers in Clifty Creek Plant of Ohio Valley Electric Corporation.

DIRECT-FIRING SYSTEM?

A Compact, Space-Saving Package of Efficient Grinding Power

More power and capacity in a compact arrangement . . . long-range dependability . . . reduced operating cost — these are the measurable results of continuous, intensive development of the modern B&W Pulverizer. It has established an outstanding production and efficiency record in thousands of commercial installations. Here are some reasons why:

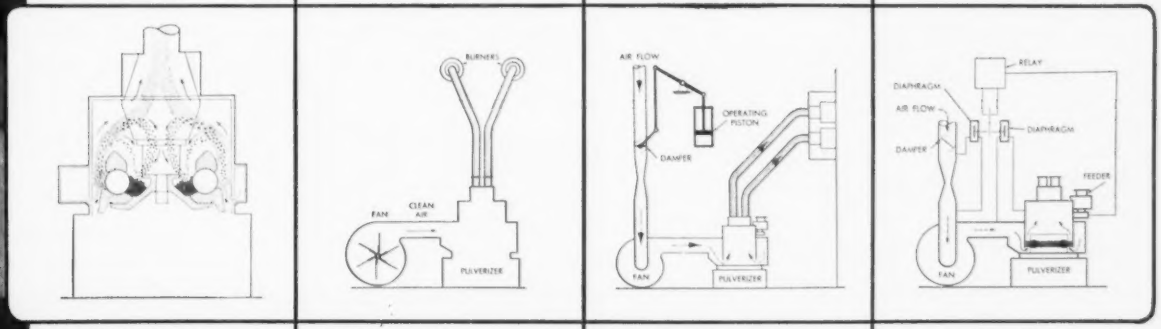
Continuous High Fineness Over Entire Service Life: Efficient combustion requires high fineness at all times. The high circulating load of the B&W Pulverizer permits efficient and dependable classification of product, so that only material of proper fineness leaves the unit. In addition, its slow-speed, spring-loaded ball bearing grinding elements maintain proper grinding contact throughout their service life.

Handles Wide Variety of Low Grade and Wet Coal: Regardless of the coal's grade or whether it's dry or soaking wet, the B&W Pulverizer's unique and exclusive recirculation of fuel through heated air assures efficient grinding . . . eliminates shutdown, capacity loss, or special attention from operators.

Simplicity of Arrangement and Reduced Maintenance: Accessibility for all normal maintenance makes it simple, quick, safe and low-cost. Adjustments are easily made while the unit is in operation. Using only clean primary air supplied under pressure, fan maintenance is substantially reduced and fuel piping is greatly simplified. Also, with the pulverizer acting as its own distributor, no special distributing devices are needed. Grinding elements are of special alloy material. They last two years or more on eastern coals and at least a year on midwestern coals.

Adaptable to All Types of Automatic Controls: Because it features "one point contact with the boiler," operation of the B&W Pulverizer is simple. The boiler's automatic combustion control is connected to the pulverizer at only one point—the damper in the primary-air duct. The pulverizer's own control system regulates all other functions, such as maintenance of proper fuel-air ratio and operating temperature.

SEND FOR DATA. For full information about the B&W Type EL Pulverizer and Pulverized-Fuel Firing Systems, write: The Babcock & Wilcox Company, Dept. P-1, 161 E. 42nd Street, New York 17, N. Y.



COAL RECIRCULATION — this means high fineness, aids drying.

PRESSURE SYSTEM — this eliminates fan wear, simplifies piping.

AIR CONTROL—this means one, simple control contact point.

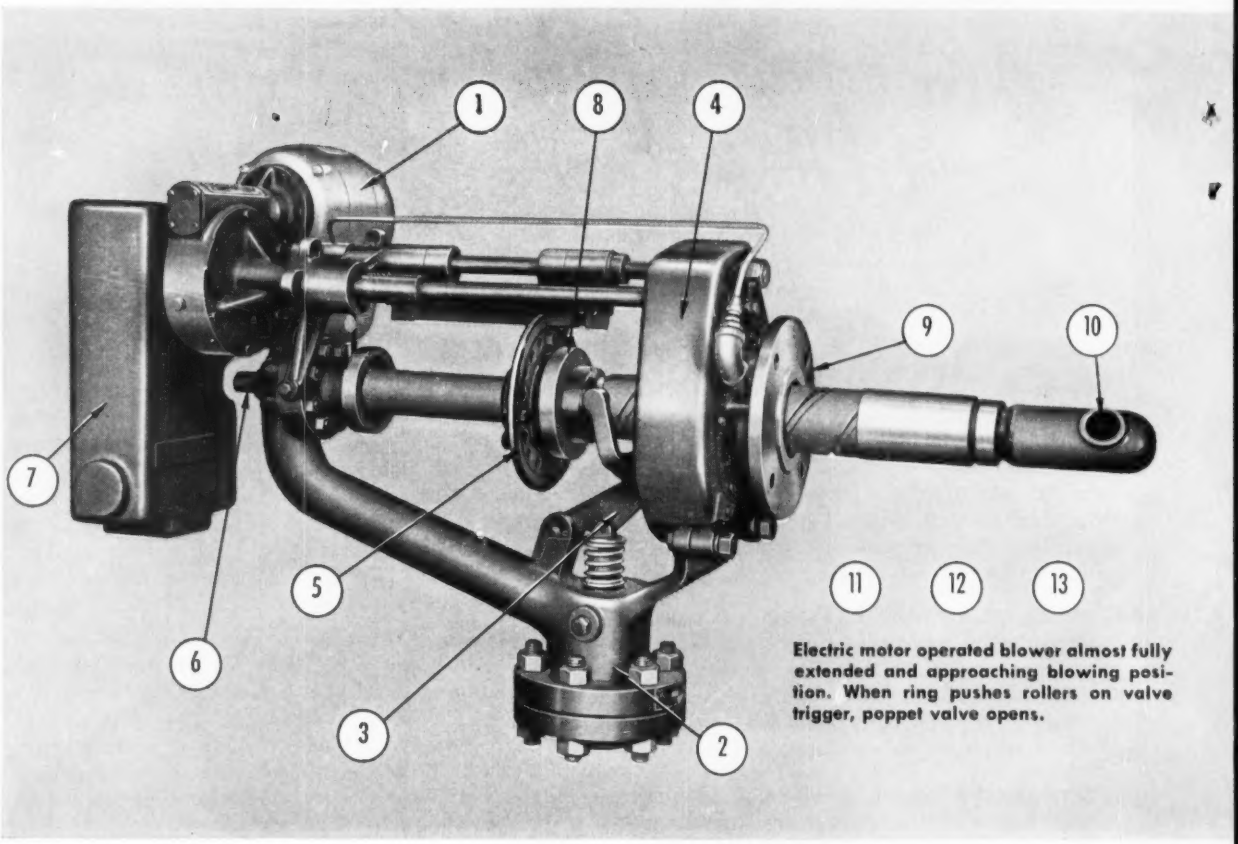
MILL LEVEL CONTROL — this automatically adjusts fuel-feed.

BABCOCK & WILCOX

BOILER DIVISION

G-766

For BETTER Boiler Cleaning



Electric motor operated blower almost fully extended and approaching blowing position. When ring pushes rollers on valve trigger, poppet valve opens.

(1) Single motor (electric or air) both rotates and propels the nozzle

(2) New high-flow poppet type valve assures tight seating without critical adjustment, has welded-in seat with stellited surfaces available.

(3) Positive mechanical action of valve without pilot or diaphragm actuation

(4) Positive mechanical drive through gears for all operations

(5) Valve can open only when nozzle is in blowing position

(6) Adjustable control for individual unit blowing pressure . . . no orifice required in line

(7) Simple, reliable control for local or remote push button operation . . . easily adapted to automatic sequential operation (either air or electric)

(8) Blowing arc easily adjusted for position and extent (up to and including 360°)

(9) Simple mounting on all types of wall construction. No other external support needed. Can mount in any position permitting piping drainage

(10) Improved blower nozzle provides more *available* cleaning energy per pound of steam or compressed air

(11) Completely automatic from start to finish

(12) Suitable for outdoor use without protection except under very severe ice conditions

(13) All operating parts readily accessible for easy maintenance

at LOWER COST

IMPROVED

MODEL IR BLOWERS

(SHORT RETRACTING LANCE TYPE)

This improved Diamond Model IR Blower does a better job of cleaning water cooled furnace walls, hopper slopes or narrow portions of tube banks adjacent to walls. The retracting feature enables it to operate in zones of extremely high gas temperature; it will remove all dust and most slag deposits over a wide radius from the nozzle.

Cleaning furnace wall tubes effectively reduces gas temperatures leaving the furnace . . . improves overall efficiency of tube bank cleaning. Also, furnace wall cleaning contributes substantially to control of superheat and reheat steam temperatures on high-duty units.

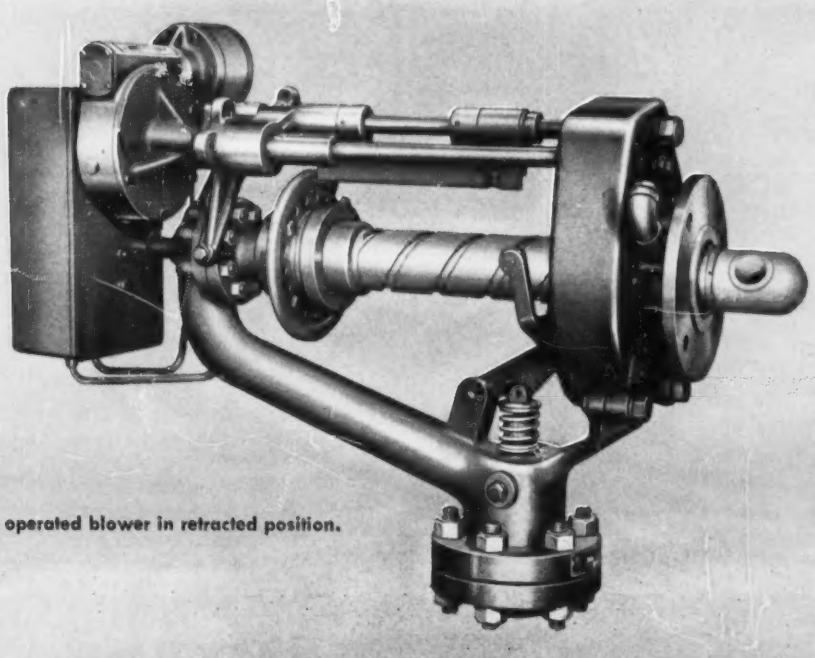
Check the features listed on the left-hand page. For additional information on the improved Model IR, ask your local Diamond office or write directly to Lancaster for a copy of Bulletin 1079AU.

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

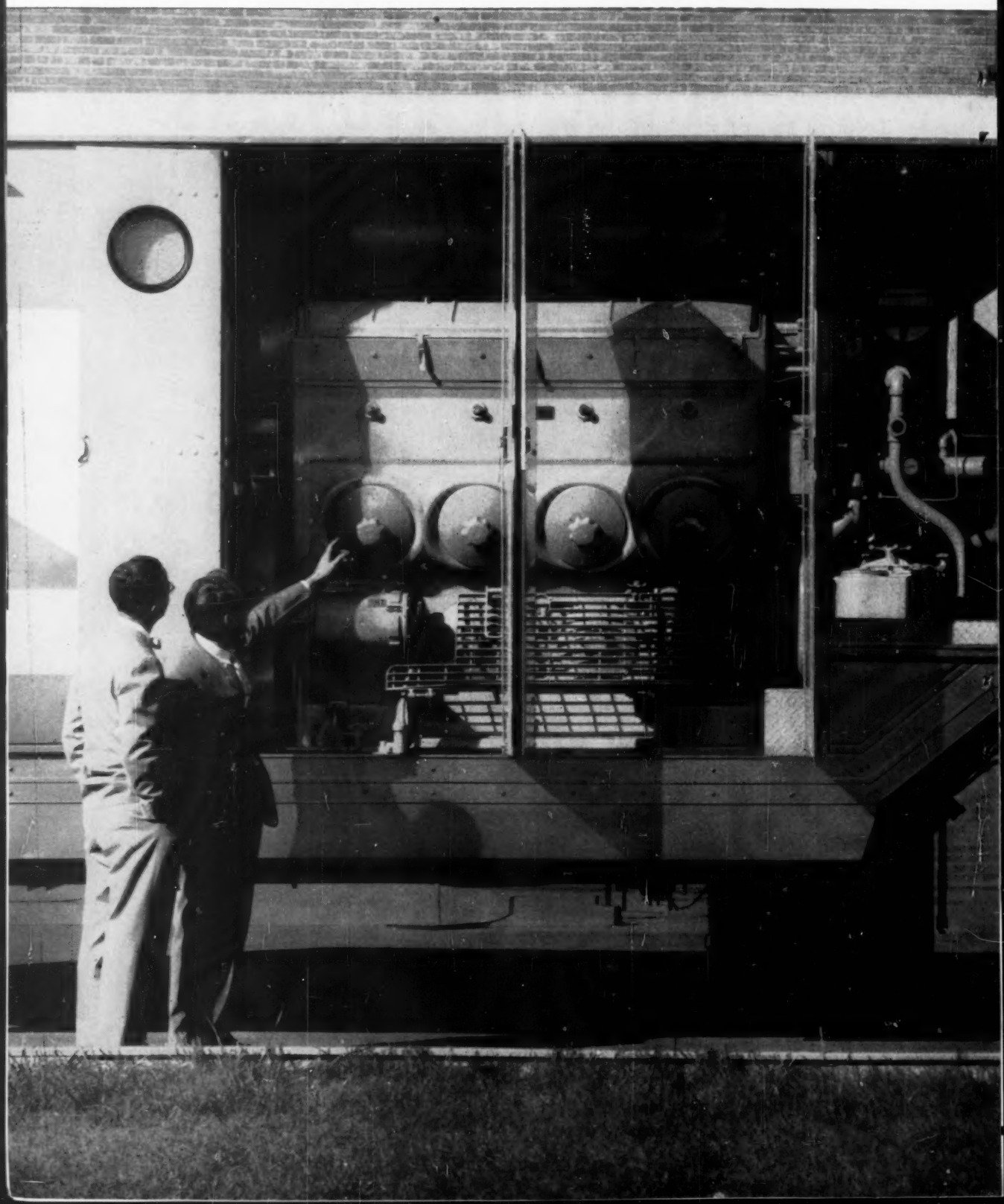
Diamond Specialty Limited, Windsor, Ontario

7949

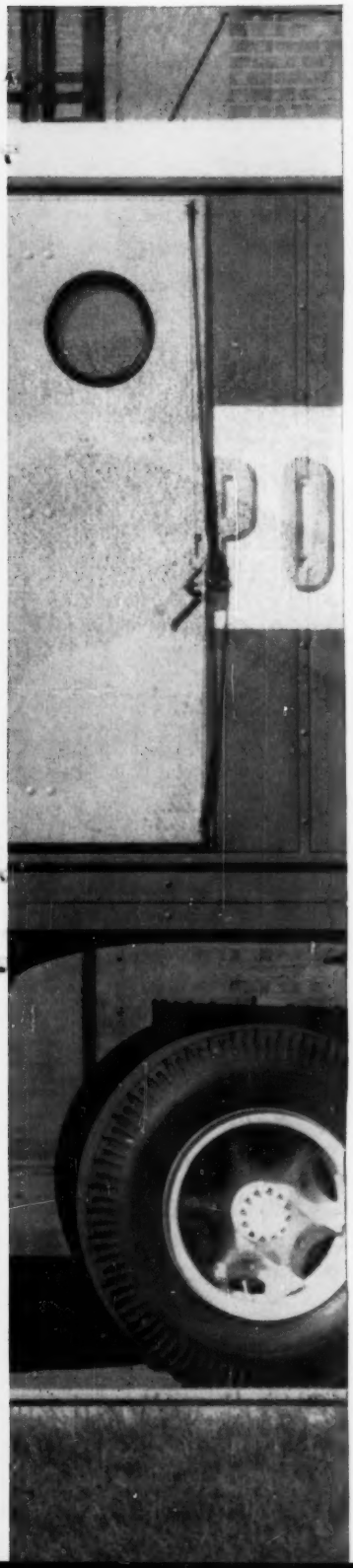


Air motor operated blower in retracted position.

Built only to



produce electric power



The Diesel engine was first designed and built for mechanical drive. It was much later that Electro-Motive incorporated this principle in designing and building a prime mover specifically for electric power generation.

It was, in fact, in 1932 that two experimental electric power generating sets were tested at the Chicago Century of Progress Exposition. These two cycle engines were a revelation in design —compact and lightweight.

Refined and improved over the years, this advanced prime mover has been produced in quantity by Electro-Motive—enough, in fact, for a total generating capacity of more than 24,000,000 kw. Above all, this engine has proved its dependability, operating for thousands of hours under every conceivable condition with only the most routine type of servicing.

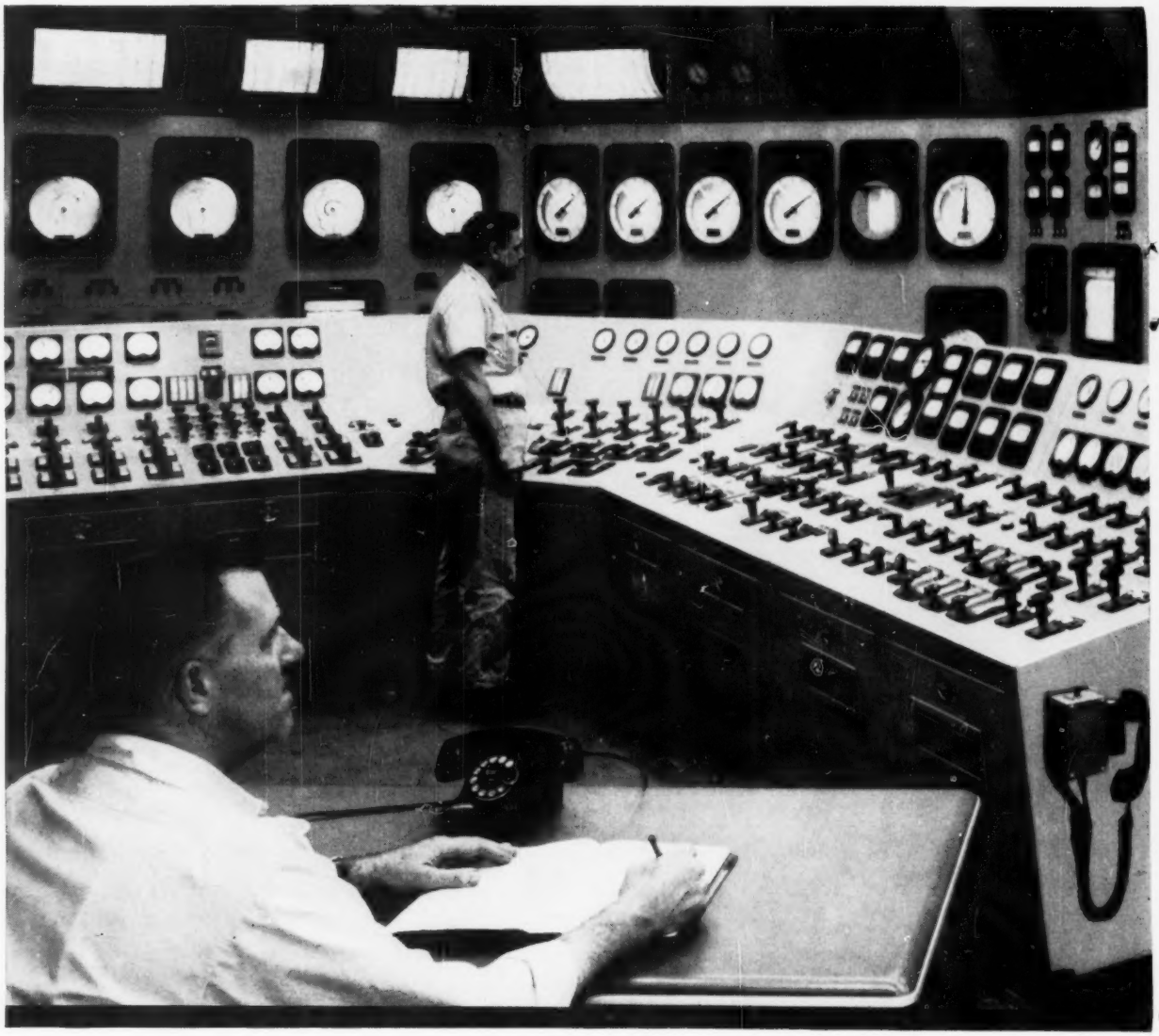
It is this wealth of tested and proven experience that is your best assurance when you install Electro-Mobile equipment. Why not discuss its potential for low load factor generation with your Electro-Motive representative?

1000 kw units for use on sidings or placed on piers for semi-permanent use.

500 kw units offer excellent mobility for many temporary applications.

LIVE BETTER ELECTRICALLY

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS
LA GRANGE, ILLINOIS
Sales offices in Chicago, New York, St. Louis, San Francisco
In Canada: General Motors Diesel Limited, London, Ontario



How Bailey makes steam

Fingertip Controls, convenient indicators, and trend recorders make steam control room operating duties a pleasure. You get this bonus for your operators when you specify Bailey Meters and Controls.

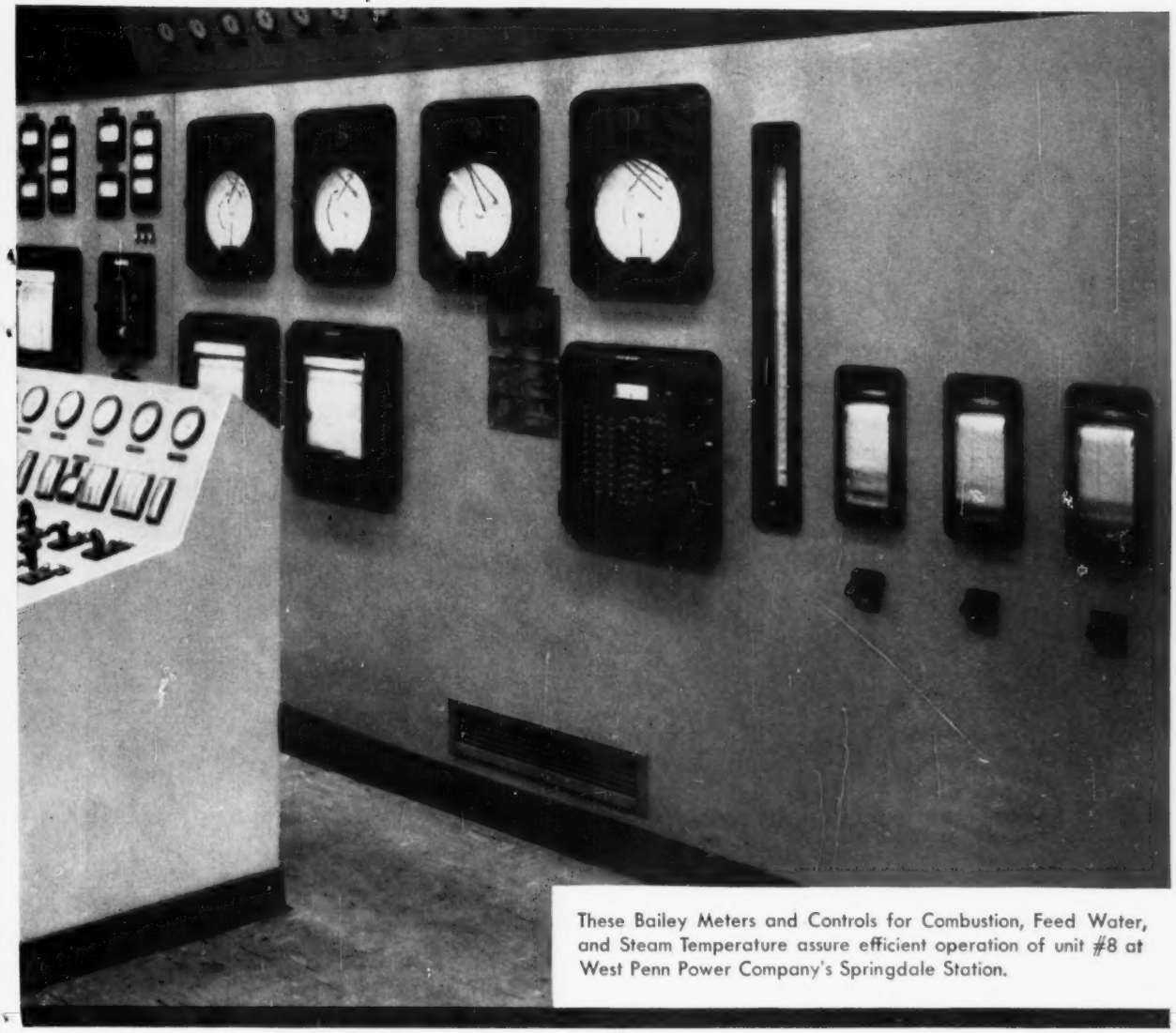
Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men



These Bailey Meters and Controls for Combustion, Feed Water, and Steam Temperature assure efficient operation of unit #8 at West Penn Power Company's Springdale Station.

operating duties a pleasure

who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

A133-2

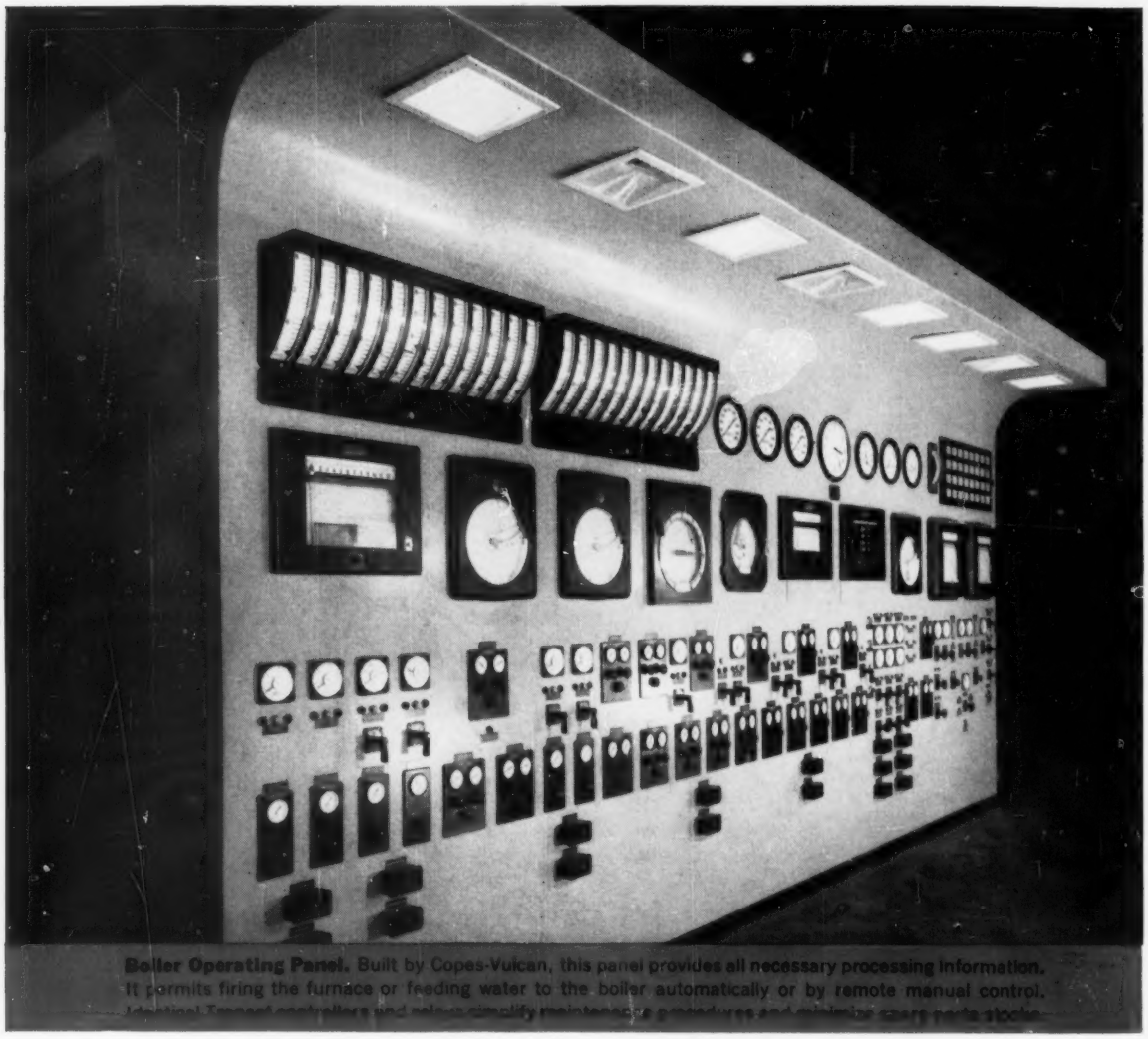
BAILEY METERS

Instruments and controls for power and process

BAILEY METER COMPANY

10 36 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal



Boiler Operating Panel. Built by Copes-Vulcan, this panel provides all necessary processing information. It permits firing the furnace or feeding water to the boiler automatically or by remote manual control.

Copes-Vulcan Boiler Control installed at Seward Station

Pennsylvania Electric Company's Seward Station uses an integrated Copes-Vulcan system to provide efficient boiler control. Built to maintain a constant main steam-header pressure under all load conditions, this modern control system provides simplicity of circuits and dependable accuracy of components.

Correcting pressure changes automatically. Fuel feed responds to deviations in steam pressure resulting from changes in steam flow rate, and generates the exact amount of steam to restore header pressure. The system also maintains constant drum level.

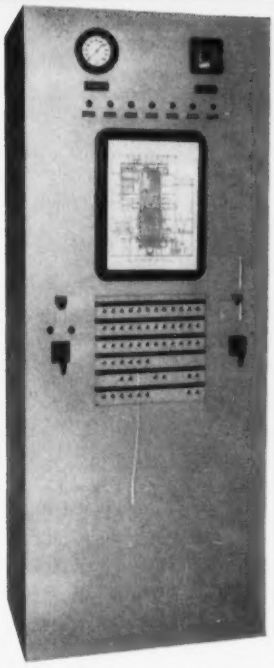
Mill temperature control, mill-totalizing circuit and boiler feed pump recirculation control are additional functions of this efficient control system.

Bumpless transfer simplifies operation. All Copes-Vulcan auto-manual stations provide a continuous picture of performance, permit automatic-to-manual selection without the complications of seal balance.

Noted for modern design, high speed response and precision performance, Copes-Vulcan boiler control systems and Vulcan soot blowing systems cut operating costs at modern stations everywhere.

Whether your boiler is large or small, power or process, your Copes-Vulcan representative has the ideas, information and experience to help you choose the system to best meet your needs.

C-V NEWS NOTES

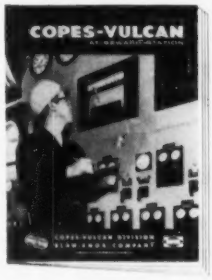


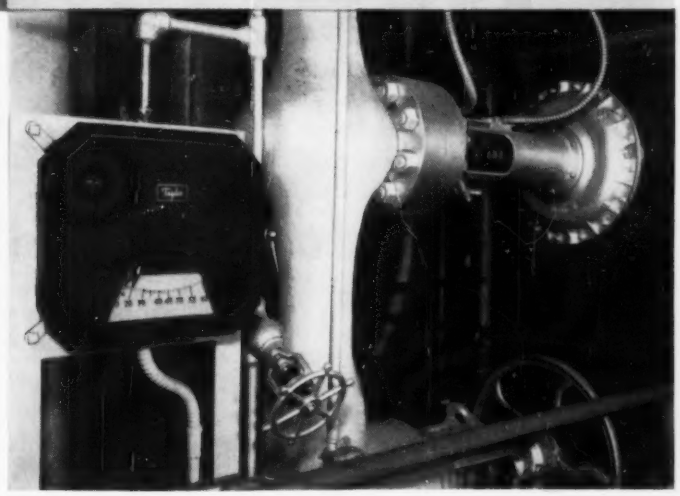
Seward's soot blower system. A Vulcan automatic-sequential control system keeps soot blowers operating in proper sequence. Panel switches permit any soot blower to be cut out of the sequence or reblown if necessary.

Fuel feed drive units. The units shown are typical of all drive units in the control system. A positioner, a four way valve, a power piston and feed-back cam are incorporated into each compact unit.

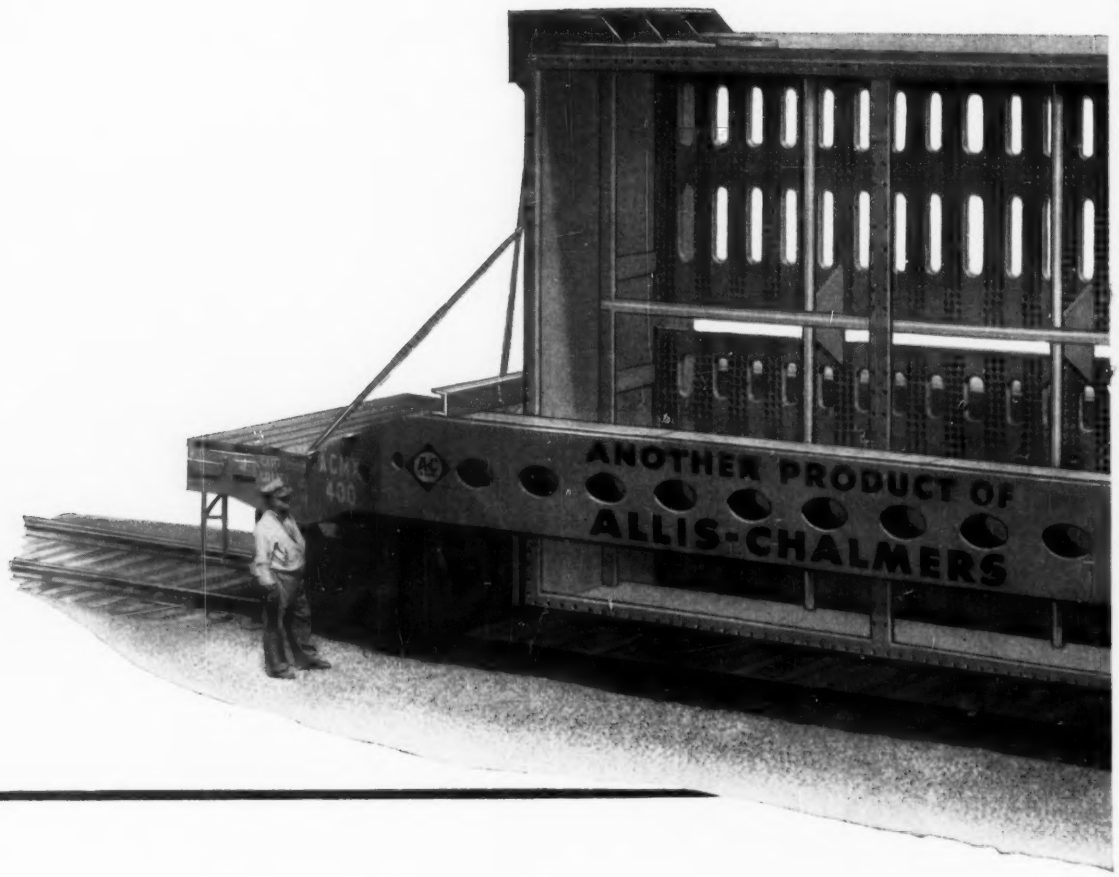
Pump recirculation control. When discharge from any pump falls below an established limit, an electric-contact low-flow control circuit opens a diaphragm operated by-pass valve to assure sufficient flow to prevent the pump from overheating.

Write for Bulletin 1038. This 12-page bulletin describes in detail Seward's complete control system. Schematic drawings show air-flow and fuel-loading loops. Boiler drawings locate Vulcan soot blowers and wall deslaggers.





COPES-VULCAN DIVISION
BLAW-KNOX COMPANY
ERIE 4, PENNSYLVANIA



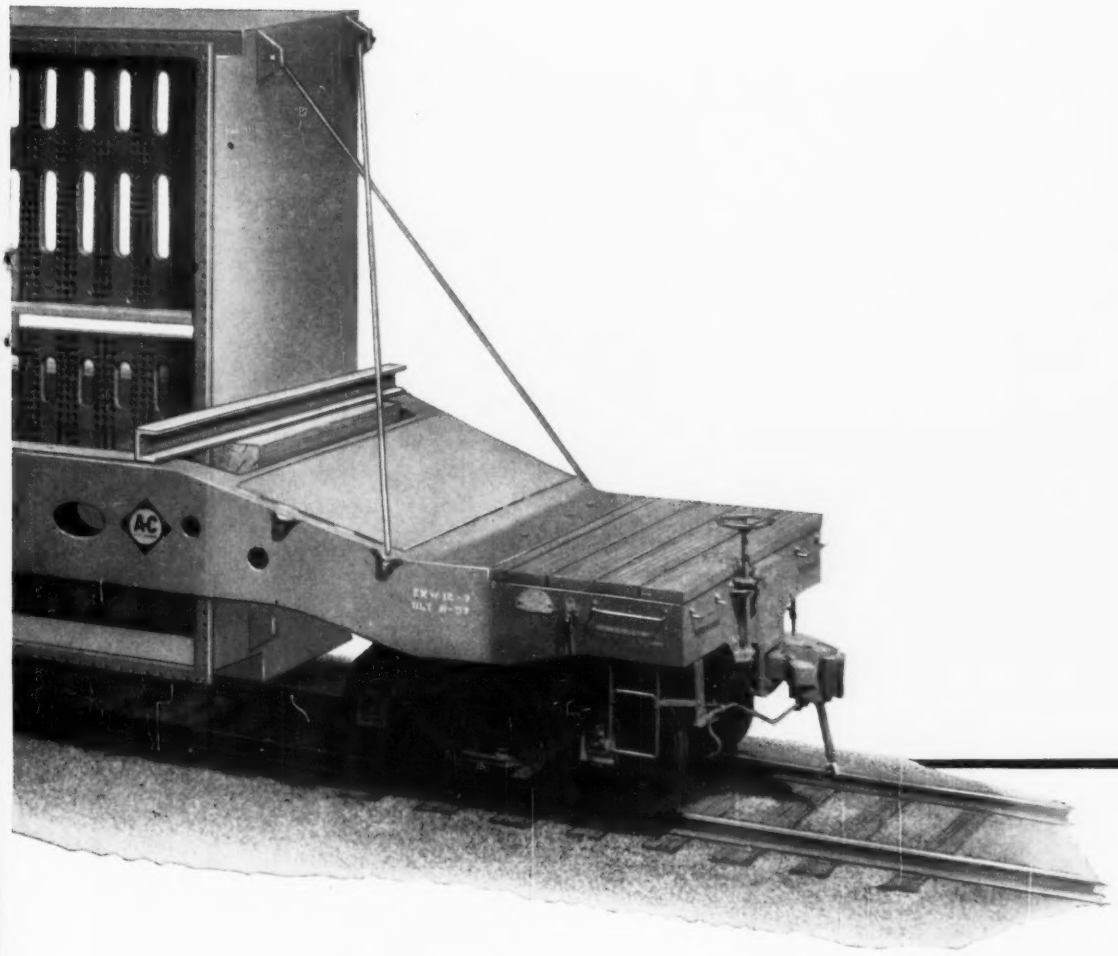
Now in Service!

New well-center cars reduce condenser erection time and costs

For details, call your nearby A-C representative or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin

A-C ALLIS-CHALMERS

A-5453



These new Allis-Chalmers cars, specially built to A-C design, carry loads of greater dimension than any conventional car can handle . . . permit shipment of larger shell sections, cut erection time at the job-site.

With an overall width of 12 feet 7 inches, these cars take shell sections up to 30 feet long, 10 feet wide, 18 feet high. Cars used previously could take sections only 7½ feet wide.

This solution to the problem of transporting continually larger condensers to ever larger power plants is an example of the attention given to *all* the problems involved in building condensers — research, engineering, manufacturing, shipping, erecting, servicing. When you specify Allis-Chalmers you get complete engineering for optimum efficiency.

Matched Auxiliaries

Whatever your requirements may be in size or shape, Allis-Chalmers can supply surface condensers and all necessary auxiliaries — circulating pumps, condensate pumps, motors, air ejectors, controls, valves — all engineered by Allis-Chalmers.

ALLIS-CHALMERS

What are your needs for

YARWAY COLOR-PORT WATER LEVEL GAGE

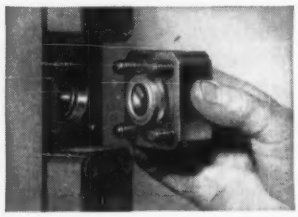
two-color readings
low-maintenance
increased availability

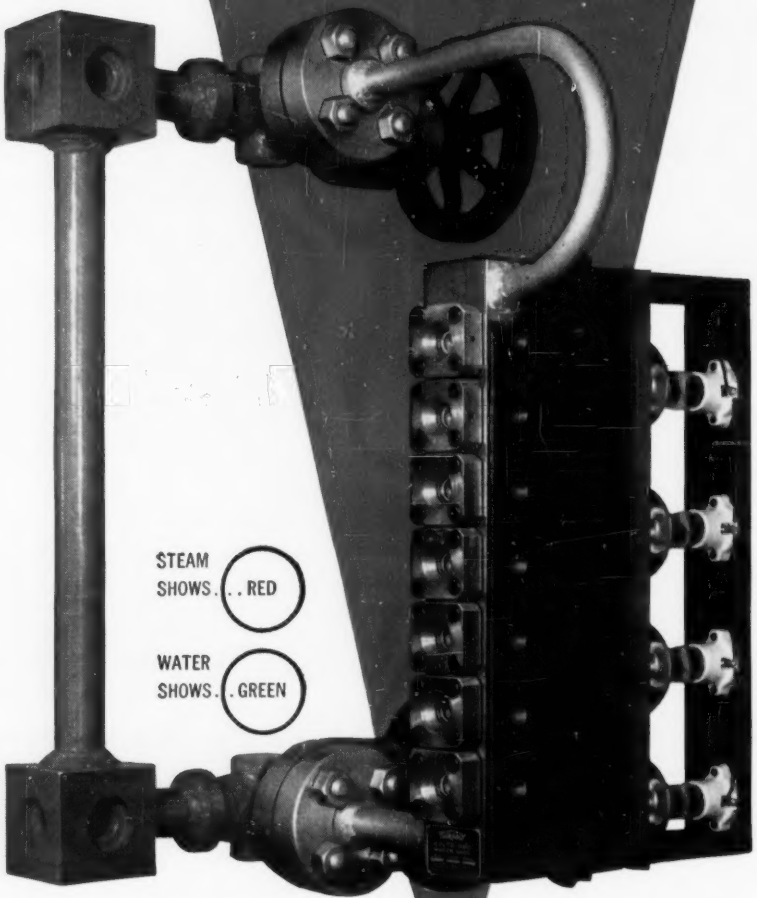
You get a *triple advantage* with the Yarway COLOR-PORT boiler water level gage for pressures to 3000 psi.

Two-color readings are brilliant and clear. Water shows green; steam shows red. A full gage is all green and an empty gage all red.

Low maintenance with individual cover-glass assemblies, each held solidly in place by four socket head cap screws. "Floating assembly" design applies safe, predetermined loads on glass ports, reducing thermal shocks, permitting faster warm-up.

Increased availability means longer service life. Cover glass assemblies can be *serviced in place*, easily and quickly.





Yarway Bulletin WG-1814 describes the Color-Port Gage. Write for it.

YARNALL-WARING COMPANY
100 Mermaid Avenue
Philadelphia 18, Pa.
Branch Offices in Principal Cities

YARWAY COLOR-PORT . . . *a good way to specify high pressure water gages*

boiler water level indication ?

YARWAY REMOTE LIQUID LEVEL INDICATORS

Boiler water levels and other liquid levels requiring remote indication can be handled completely by a Yarway system

Heart of the system is the Yarway Remote Liquid Level Indicator that gives instant, accurate readings because the mechanism is operated by the boiler water or other liquid itself. The pointer mechanism is never under pressure. Clear, "wide vision" face permits easy readings from any angle

The Yarway Indicator conforms with A.S.M.E. Boiler Code Committee ruling (Case #1155) permitting two independent remote level indicators of compensated manometric type to replace one of two required gage glasses for boiler pressures 900 psi and above.

Electronic Secondary Indicators can be added at any point in the plant. Remote Hi-Lo Alarm Signals (lights and/or horns) can be connected for additional safety.

Primary indicators fully compensated for every pressure change in boiler also available.

For permanent record of changing levels, the Yarway Hi-Lo-Graph Recorder can be furnished.

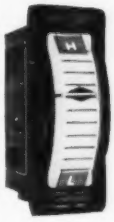
Over 10,000 Yarway Remote Indicators have already been installed. For full details, write for Yarway Bulletin WG-1824.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
Branch Offices in Principal Cities

FULLY COMPENSATED INDICATORS

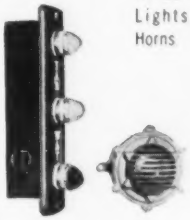
for completely accurate indication under every boiler operating condition

ELECTRONIC SECONDARY INDICATORS



To supply additional indication at any point without pressure connections.

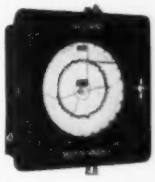
REMOTE SIGNALS



Hi-Lo Alarms Lights and/or Horns

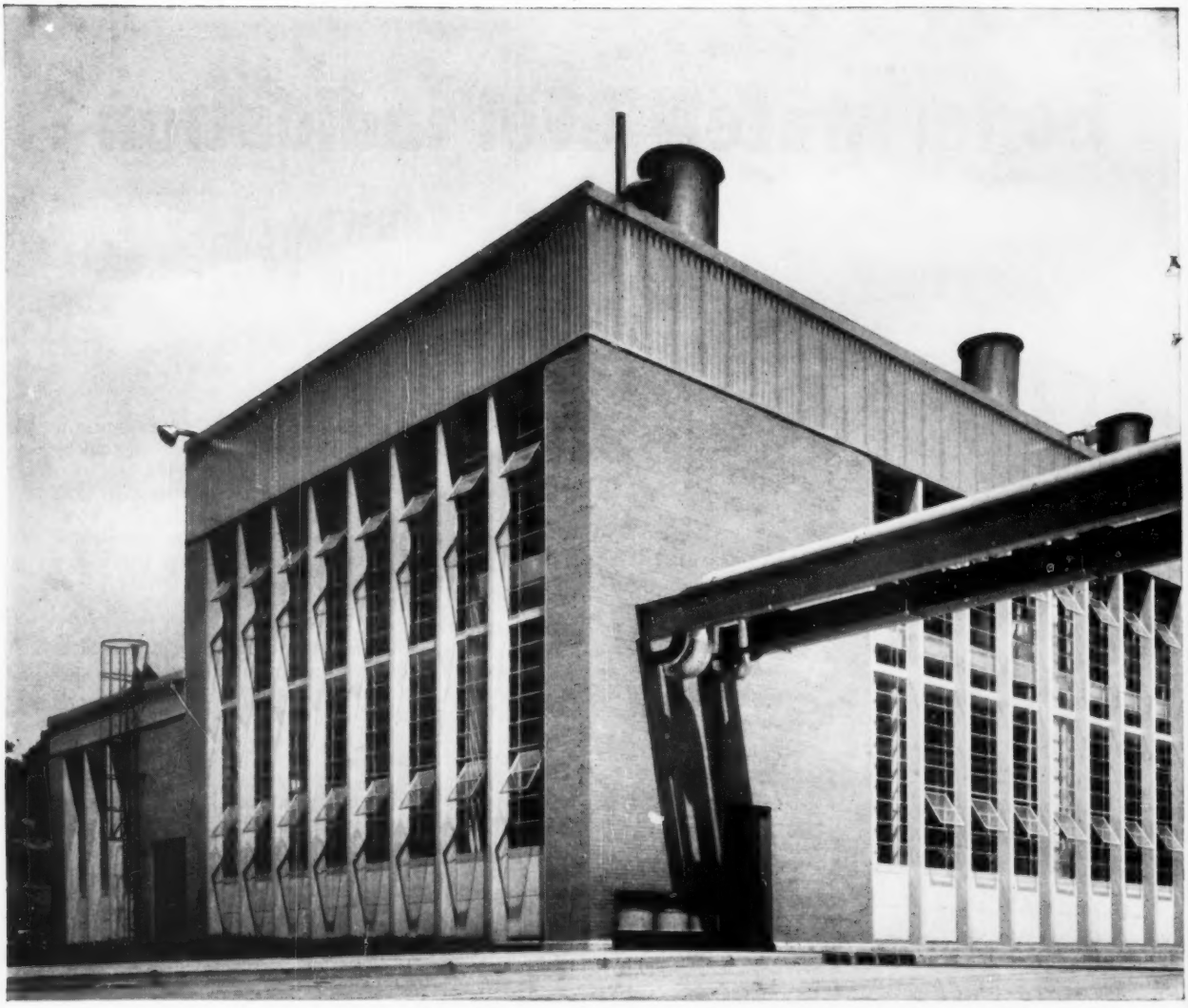
RECORDERS

To provide permanent 24-hour record of liquid levels.



YARWAY

. . . a good way to specify remote liquid level indicators



Boiler House at New Helicopter Plant Sikorsky Division, United Aircraft Corp. F. A. Fairbrother and Geo. H. Miehls, Architect and Engineer; Albert Kahn Associated Architects and Engineers, Consultants.

SIKORSKY'S MODERN BOILER INSTALLATION "BUFFALO" DRAFT FANS

Power magazine, May, 1957 issue, said this about Sikorsky's new power service setup: "A top example of today's design practice for medium-sized plants . . . its boiler house, in particular, resulted in its selection by *Factory* magazine as one of the most significant plants erected in the U.S. in 1955."

Six "Buffalo" Fans are installed assuring the efficient, dependable, continuous functioning of the steam generating equipment. Three "Buffalo" Fans handle forced-draft requirements: 160,500 lb. air per hr., 6.05 in. wg, 100 F, 37,800 cfm, single inlet, variable inlet vanes, class II, two motor-driven, one motor- or turbine-driven.

The other three "Buffalo" Fans perform the induced-draft job: 180,900 lb. gas per hour, 4.6 in. wg, 405 F, 63,000 cfm, single width, single inlet, one unit set up for dual drive, two motor-driven, one motor- or turbine-driven. Selection of "Buffalo" Fans for this type of demanding service reflects the confidence of engineers, contractors and owners in our mechanical draft fans . . . earned by our 80 years of engineering experience and manufacturing integrity. Such confidence is equally inspired by the famous "Q" Factor — the

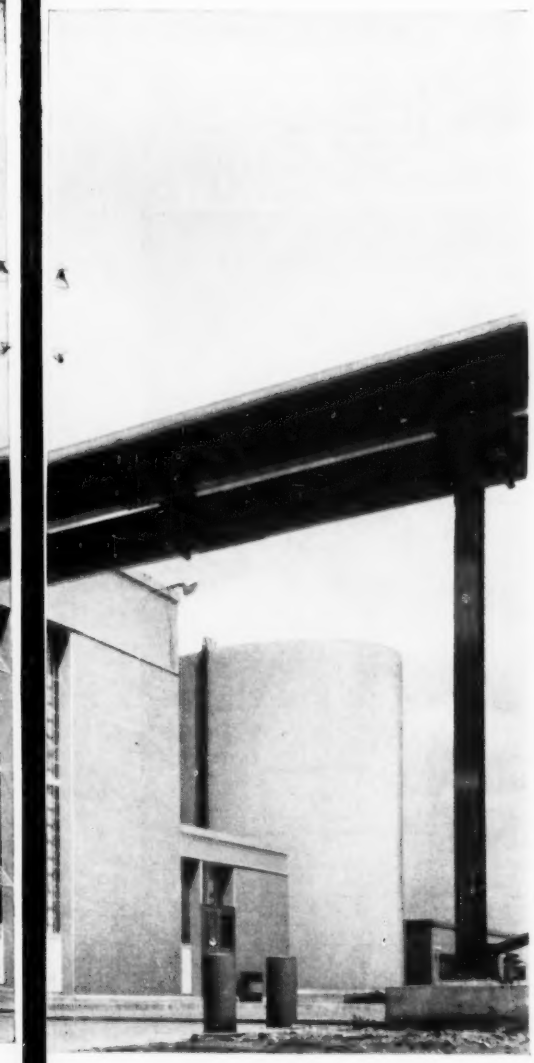
"Buffalo"

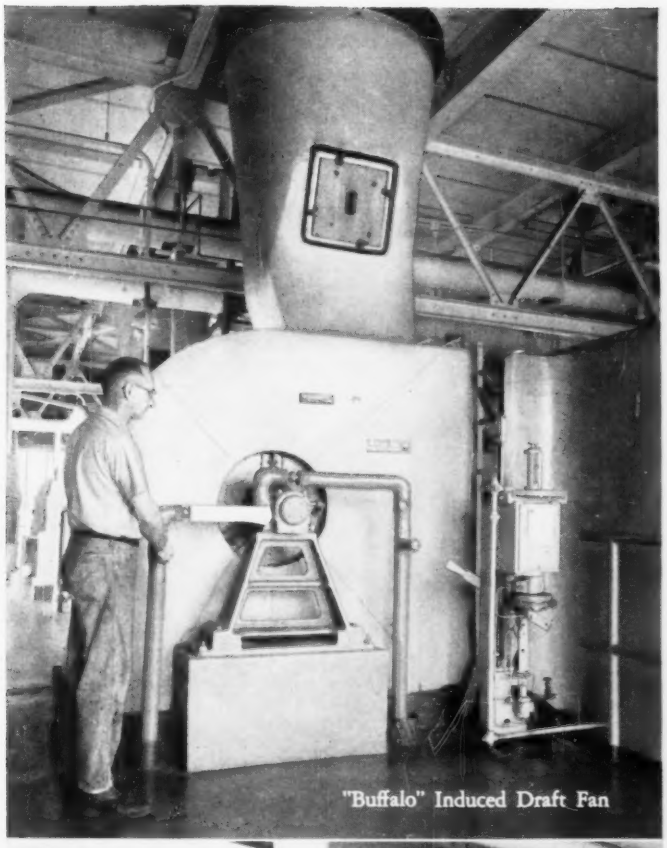
BUFFALO

BUFFALO, Canadian Blower & Forge

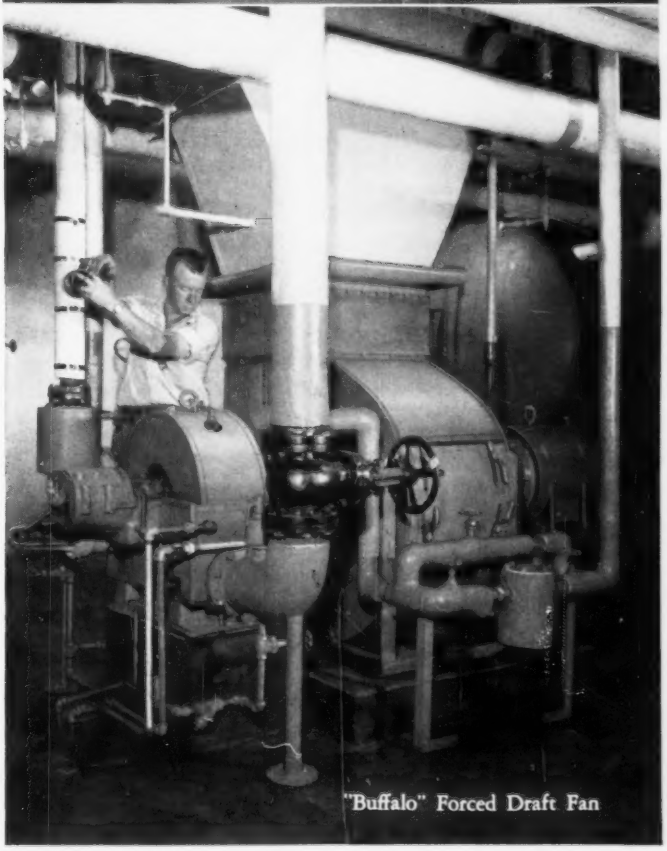
VENTILATING AIR CLEANING AIR TEMPERING

FORCED DRAFT COOLING HEATING





"Buffalo" Induced Draft Fan



"Buffalo" Forced Draft Fan

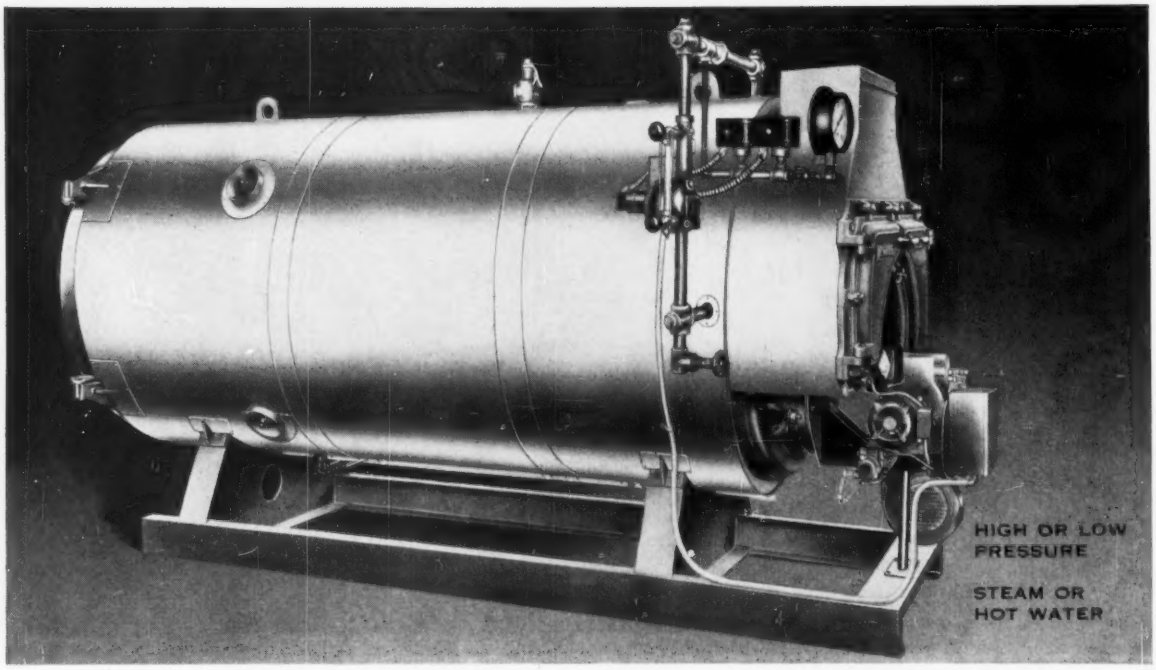
INCORPORATES

built-in Quality which provides trouble-free satisfaction and long life in every "Buffalo" product. Let us solve *your* mechanical draft requirements satisfactorily, economically, reliably. Contact your nearest "Buffalo" Engineering Representative, or write us for full information.

FORGE COMPANY
NEW YORK
Co., Ltd., Kitchener, Ont.

INDUCED DRAFT EXHAUSTING
PRESSURE BLOWING

Announcing 8 new KEWANEE



Kewanee low pressure boiler with Iron Fireman MicroMist forced draft burner for heavy oil.

All advantages of forced draft firing now available in smaller size series

READ THESE SPECIFICATIONS. SIZE RANGE: 18 to 92 bhp. FUELS: Light or heavy oils, gas, or combination oil-gas. FACTORY ASSEMBLY: All models available factory assembled as complete package units, ready for service connections on job.

In the new Kewanee-Iron Fireman series of package units, the important advantages of forced draft firing are extended to the small "Scottie, Jr." sizes. Thoroughly proved in worldwide installations of larger size units, this new series makes forced draft firing, with all its benefits, available for smaller boiler plants.

Forced draft advantages. Forced draft firing has many inherent advantages over other methods of gas or oil combustion.

With these units there is a 50% saving in electrical power for operating motors. This is important, particularly in the larger sizes. More positive regulation is assured by controlling the air at room temperature, rather than at exit gas temperature. Equipment is smaller and requires less maintenance. In addition, a forced draft unit is much quieter than a natural or induced draft unit. No high stack needed; requires only a vent pipe.

Boilers and burners conservatively rated. There is an ample reserve capacity beyond the rated output. Normal load is carried at a comfortable "cruising speed." This assures long life with low maintenance costs. Units operate at well above 80% efficiency even at 50% above the Steel Boiler Institute rating.

Only service connections required. All boiler fittings, automatic burner controls, fuel and air systems are installed and tested at factory. Units are fire tested and shipped as a unit if desired, or boiler and burner may be shipped separately if it is necessary to protect the burner from weather or vandalism during construction.

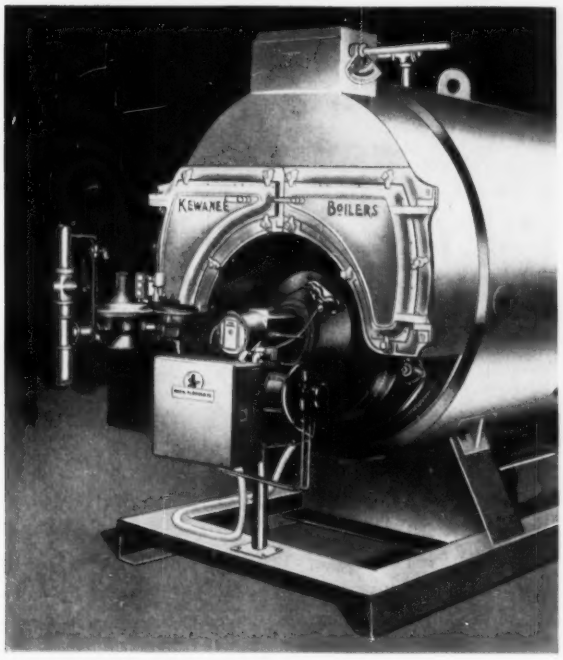
IRON FIREMAN forced draft package units

High or low pressure, steam or hot water boilers . . . all sizes, all fuels . . . *ready to hook up and GO*

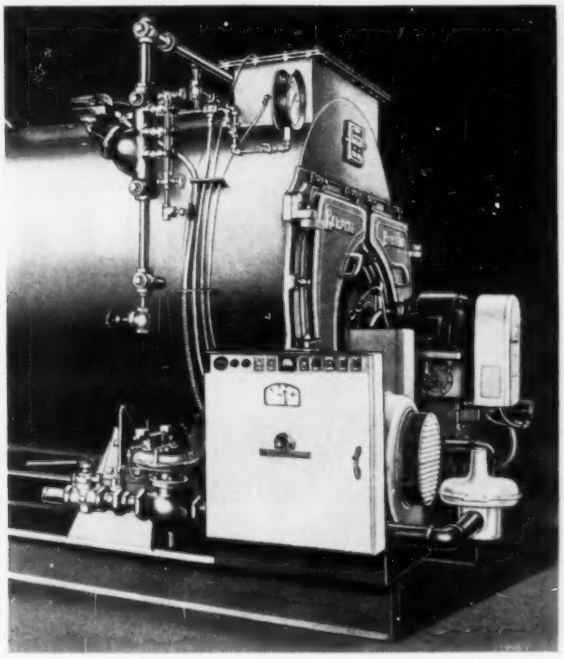
Light oil, gas or gas-oil. The Iron Fireman WhirlBlast burner is a new and advanced design. Its most outstanding feature is its ability to fire, with high efficiency, either gas or oil in a sealed combustion chamber, without flame pulsation. It is a true forced draft burner operating under firebox pressure. On dual fuel models, fuels are changed without mechanical adjustment, either through automatic controls or with the flick of a switch. From 18 to 92 bhp.

Heavy oil burner for smaller boilers. The ability to fire either heavy or light oils and to modulate over a wide range are the two outstanding features that make the MicroMist burner unique in its field. Its most notable feature is a two-stage supercharger atomizing principle which converts fuel oils, up to and including No. 5, to an air-oil mist that is readily ignited by an electric spark. No gas pilot required. For boilers from 18 to 92 bhp.

No. 6 oil or lighter—gas or gas-oil. This burner is designed for larger size boilers. Oil models incorporate the famous Iron Fireman horizontal rotary burner with Volumeter oil control, which accurately meters, by positive displacement, all grades of oil. The integrated ring type gas burner operates at highest efficiency at the same input ratings as are developed with oil. Available in sixteen sizes with capacity ranging from 59 bhp to 651 bhp.



Iron Fireman WhirlBlast burner (described above) fires either gas or light oil, or combination oil and gas, under forced draft. This is a new Iron Fireman development; never before available in the medium size range.



The Iron Fireman rotary forced draft burner (described above) fires any grade of oil, gas or gas-oil combination. It includes control panel, air and fuel systems. Control instruments are wired and tested at factory.

Write for catalog and specifications

IRON FIREMAN®

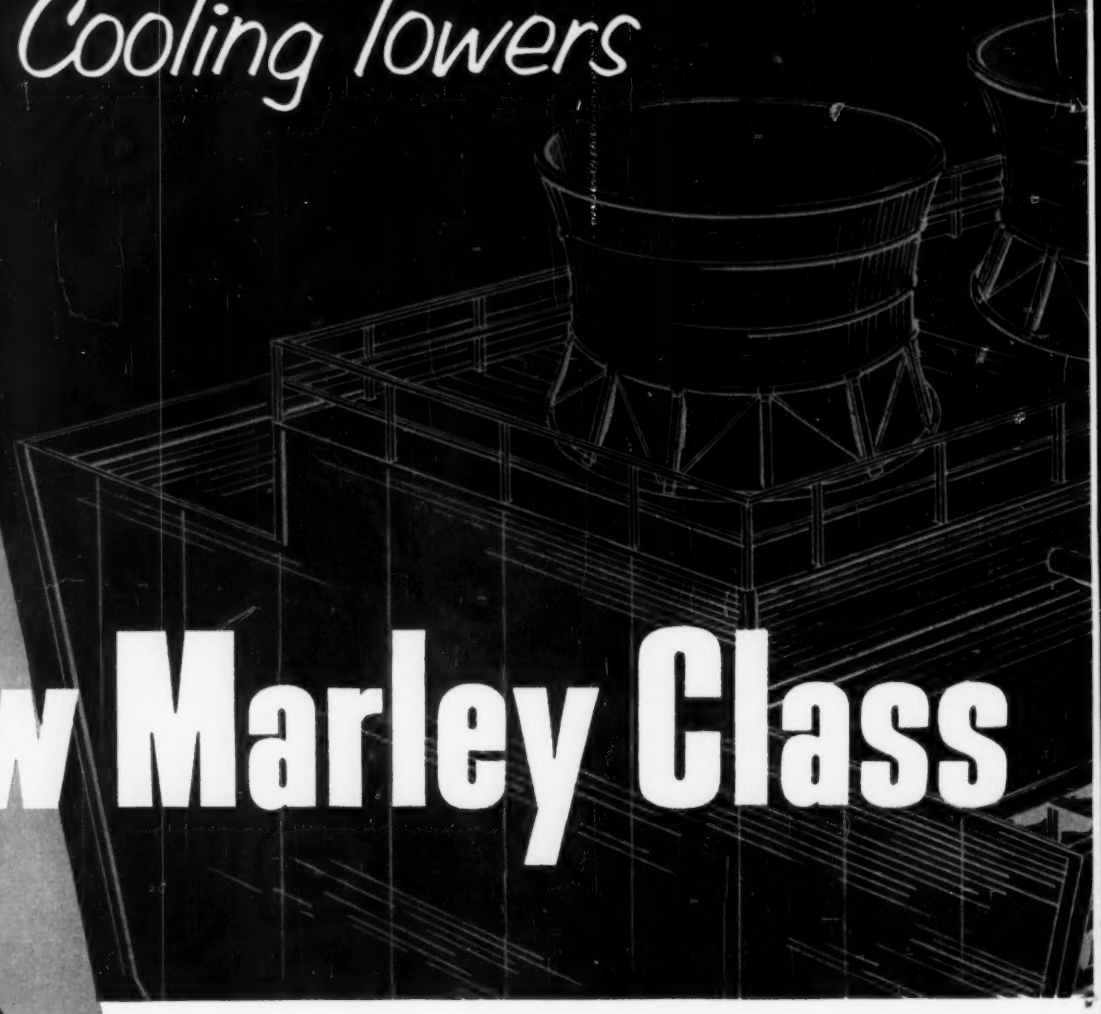
AUTOMATIC FIRING EQUIPMENT FOR HEATING, PROCESSING, POWER

IRON FIREMAN MANUFACTURING CO.
3035 West 106th Street, Cleveland 11, Ohio
In Canada: Write 80 Ward Street, Toronto, Ontario.
Please send complete technical description and specifications.

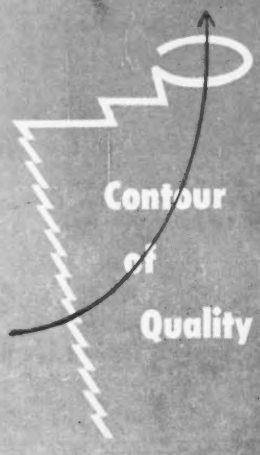
☐ low pressure ☐ new 18 to 92 hp. units only
☐ high pressure ☐ all capacities

Name_____
Company_____
Address_____
City_____ Zone____ State____

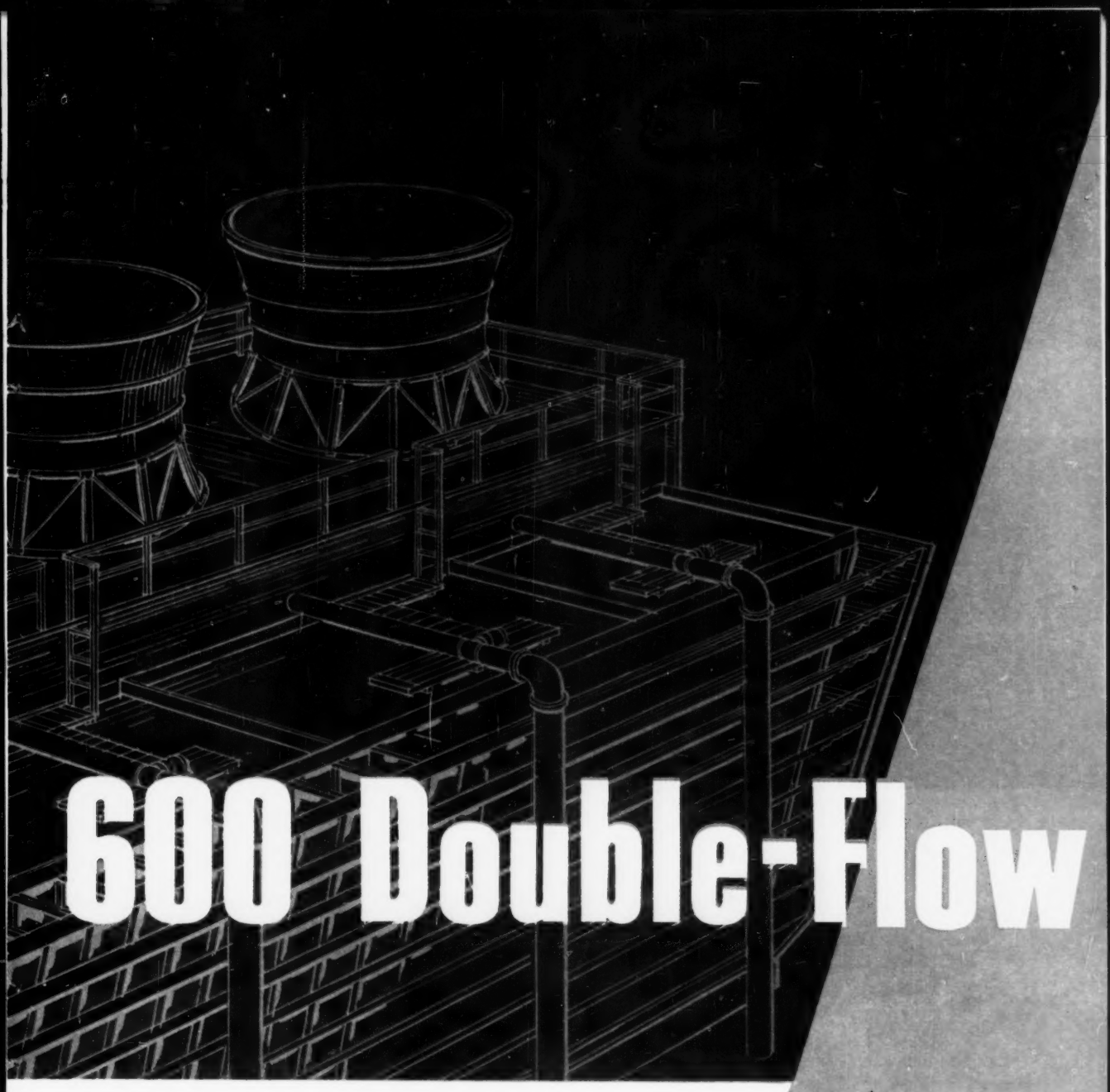
A new slant on industrial Cooling Towers



New Marley Class

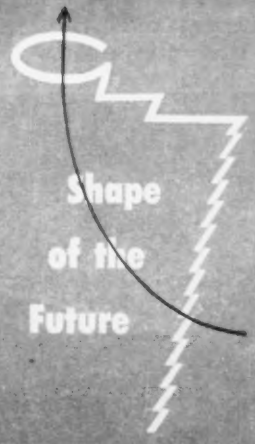


NEW IN PROFILE — NEW IN PERFORMANCE. These characteristic advances announce a forward trend in cooling towers and introduce the new Marley Class 600 Double-Flow and Single-Flow models. They embody design improvements that are seven-league strides in water cooling practice and achievement. • • • The new profile is completely functional. It is the basis of many fundamental changes that mean increased cooling capacity in every frame size with greater power economy and no additional basin cost. Class 600 Cross-Flows have more filling and the ability to keep more water in the fill area; to reduce direct, unbroken water fall. The fill is of uniform width at all elevations, exposing the water to equalized air flow at all points of the cooling chamber. • • • From the new wide louvered walls to the fan, air flow is cleared of obstructing elements. Pressure control and air



600 Double-Flow

discharge are more proficient. This lowered draft loss efficiently balances increased water capacity in Class 600 Cross Flows. • • • The angled louver walls make possible simple controls that facilitate winter operation in areas where icing is a problem. • • • In Class 600 Cross-Flows extended durability—increased resistance to corrosion—keeps pace with stepped-up cooling ability. They are the first standard models completely asbestos cement board encased, and they introduce inert materials for use throughout the structure. • • • These towers establish a quality standard new to water cooling equipment and of importance to you as an investor. You can get all detailed information from the nearest Marley engineer in 56 major cities or by writing direct.



The Marley Company
Kansas City, Missouri

MARLEY

Maintenance engineering

You can arrange to have a Honeywell service engineer visit your plant at regular intervals to inspect, clean, and adjust your instruments and controls. He's factory-trained and field-experienced in keeping good instruments in top operating condition. If an emergency should arise, a phone call will bring a Honeywell service engineer to your plant in a hurry.

Spare parts, in a rush

A Honeywell branch office near you can be your storeroom for standard parts . . . in addition, the Parts Depot in Philadelphia carries a complete stock of all normally used parts. With Honeywell stocking your spare parts, you save storage and inventory control costs. Most shipments are made within 24 hours after orders are received.

Service is the

Practical service training

The tuition-free Honeywell Training School teaches your instrument technicians the most up-to-date maintenance methods, fits them for the kind of problems they may encounter on the job. Intensive courses range from two to fourteen weeks.

Application engineering

Experienced Honeywell application engineers know your industry and processes. They design *complete* systems of instrumentation, reducing the work of your own engineering staff. From the broad Honeywell line, they recommend instruments that are exactly right for the job. And because Honeywell supplies all types of instruments, recommendations are made without bias. Service engineers will, if needed, help with installation and startup of your system.

big extra you get with Honeywell instrumentation

Honeywell offers you far more than instruments. You get service whenever and wherever you need it . . . service that begins when you first decide you need instruments, and continues long after they're installed. This service is always conveniently close at hand, for there are more than 110 Honeywell sales and service centers located strategically throughout the U. S. and Canada.

Prompt, competent service by nearby field specialists is an important plus-value of Honeywell instrumentation. Your local Honeywell sales engineer has all the facts on this service as it relates to your instrumentation needs. Give him a call . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

Architect: KENNETH FRANZHEIM, HOUSTON, TEXAS
Consulting Engineer: H. E. BOVAY, JR.
General Contractor: W. S. BELLOWS CONSTRUCTION CO., HOUSTON, TEXAS
Mechanical Contractors: BARBER, INC., and STRAUS-FRANK CO., HOUSTON, TEXAS

Air-conditioning the ultramodern

Bank of the Southwest

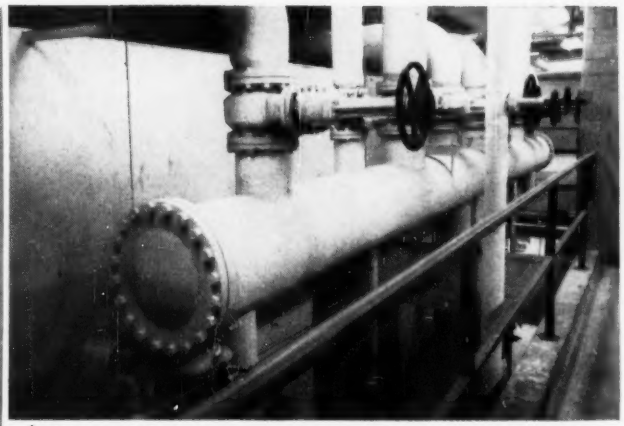
In Houston, Texas, covering a solid city block, is one of the most architecturally sophisticated banks in the Southwest. Its four-story base, sheathed in red granite, encloses a spacious bank and a panorama of shopping arcades. Topping the base is a gleaming tower of business offices.

Completely air-conditioned, the new Bank of the Southwest building employs over 150 tons of USS NATIONAL Seamless Steel Pipe in its vast system. Sizes range from 2 inches in diameter through 20 inches.

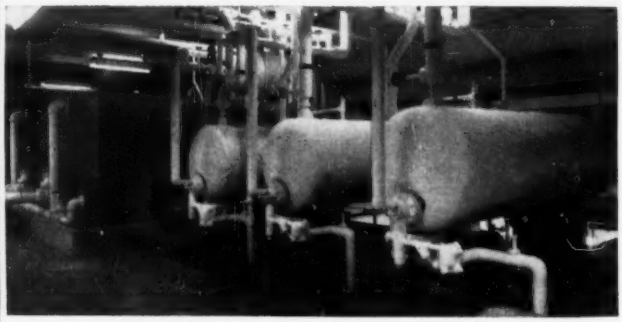
USS NATIONAL Seamless Pipe is consistently the number one choice of engineers and contractors throughout the country for air-conditioning, heating and power installations. Its ability to render efficient, trouble-free service under all types of pressure and temperature conditions has given NATIONAL Seamless a reputation for safety and dependability excelled by no other pipe. For further information or assistance with your pipe problems, get in touch with us.

NATIONAL TUBE DIVISION,
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO,
PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

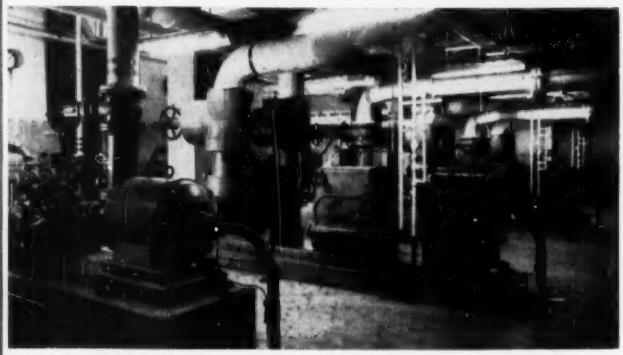
NATIONAL PIPE — USS —



20-inch drop header with 10-inch boiler leads on the steam heater system take-off from the boilers. All NATIONAL Seamless.



4-inch domestic hot water piping to generators and surge tanks. All NATIONAL Seamless.



12-inch NATIONAL Seamless Pipe from tower to main condenser and chill water pumps and gear boxes.

UNITED STATES STEEL

"OUT IN THE OPEN"

Vogt

Steam Generators

for

CHEMICAL PLANTS

and

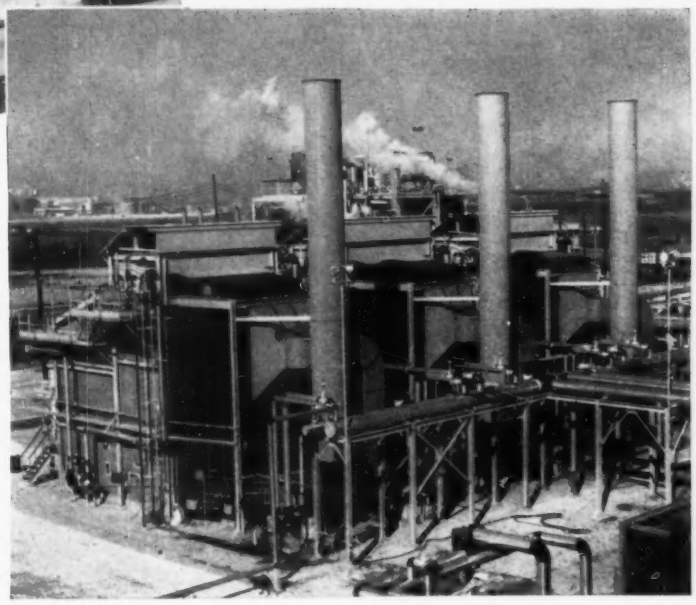
PETROLEUM REFINERIES

STEAM GENERATORS for economical outdoor operation have been featured by Vogt for many years and serve leading chemical plants and petroleum refineries. Requiring no building for housing, such installations, as pictured here, produce more steam per dollar of investment and are a definite aid to lower production costs.

Get Vogt's recommendations for steam generators to meet your needs for power, processing, or heating, without obligation. Package type and custom built units are available in a wide range of types, capacities, and pressures to meet operating requirements.

Write for bulletins. Dept. 24A-BP

Three 85,000 #/hr. steam generators in a Texas refinery.



An outstanding chemical plant served by three 150,000 #/hr. units.

OTHER VOGT PRODUCTS

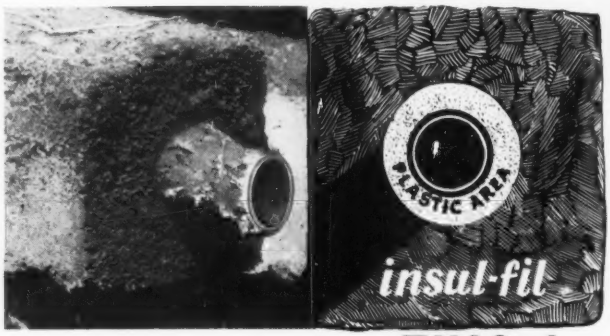
Drop Forged Steel Valves, Fittings and Flanges — Petroleum Refinery and Chemical Plant Equipment
Heat Exchangers
Ice Making and Refrigerating Equipment

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

SALES OFFICES: New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va., Cincinnati

This is an illusion

HOLD this Diagram by the right hand bottom corner and give it a slight but *rapid* circular twisting motion, at which time *each circle will separately revolve on its own axis*. The inner cogged wheel will be seen to revolve in an opposite direction.



THIS *is the real thing!*

insul-fil® the most highly efficient and economical "poured-type-insulation" available for underground steam and hot water distribution systems

The following comparative "K" factors were recorded at the Research and Development laboratories of the Atlantic Refining Company, and are evidence of INSUL-FIL's superiority.

The average "K" factor at 150 p.s.i.g. indicated the following values. These values were computed using 6" of material for the comparative evaluation. The average "K" factor on INSUL-FIL and 100% mined asphalt vary slightly depending on thickness of application.

"K" VALUES:

PERLITE	.39
INSUL-FIL	.451
100% MINED ASPHALT	.74
SOIL	3.12

Installing contractor Rhode Island Covering Co., U. S. Naval Air Station, Quonset Point, R. I., Charles A. Maguire and Associates, Consulting Engineers, Boston, Mass., Providence, R. I.

Installing INSUL-FIL at Idlewild International Airport for Port of New York Authority. (Seelye, Stevenson, Value & Knecht — Consulting Engineers)

COLLEGES and INDUSTRY use *insul-fil*. Can you afford not to?

INSUL-FIL CO., INC. A DIVISION OF
MIRACLE ADHESIVES CORPORATION 250 Pettit Avenue, Bellmore, L. I., N. Y.

Send now for your **FREE** copy of MIRA-DATA SHEET #9, 4 page colorful brochure describing INSUL-FIL.

NAME_____

COMPANY_____

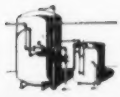
ADDRESS_____

CITY_____ ZONE____ STATE_____

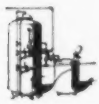
FIELD ENGINEERS AVAILABLE FOR TECHNICAL ADVICE —

Other Miracle Products for the Insulation Industry:

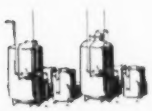
Zip-on Protektinsul Vinyl Pipe Covering
Zip-on Protekto-Flex, Vinyl Covered Fibrous Glass Insulation
Miracle Surface Anchors
Miracle Insulation Adhesives
Miracle Duct Sealer



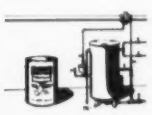
ZEOLITE WATER SOFTENER — manual and automatic. Up to 44% more soft water output from a softener of given size.



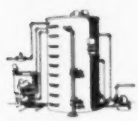
ULTRA-DEIONIZERS — produce highest quality mineral-free water. Replace distillation methods at fraction of distillation cost.



DEALKALIZATION & ION EXCHANGE SYSTEMS—Dealkalizers to control alkalinity. Ion Exchangers to produce water of any desired quality.



CHEMICAL TREATMENT SYSTEMS—prevent scale, corrosion and depositions with Elgin specially formulated chemicals.



CLARIFIER—for removing excess alkalinity and solids for clarification of turbid waters.

DEGASITORS—for removal of entrained gases from water by aeration.

How'll you have your water?

THE answer to "How'll you have your water?" depends on whether *you* are drinking it or your *plant* is drinking it. When the water is for boilers or industrial processes, it pays to be all-fired particular about every drop of it.

That's where Elgin comes in: Elgin methods and equipment can take your raw water and "make it over" into water with the exact characteristics you require. Since Elgin systems embrace all sound methods, Elgin recommendations are necessarily unbiased. The only question asked is, — what method gives exactly what is needed at the lowest possible cost?

And nearly a half century of specialization goes into the Elgin answer to that vital question!

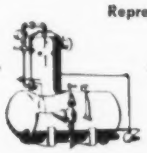
Some of the Elgin systems that may fit your needs are listed here . . . and there are many more that can be "tailored" to your specific needs.

Elgin experience is available to you through our district engineer. Write, and we will put him in touch with you . . . no cost or obligation whatever.

ELGIN SOFTENER CORPORATION

130 No. Grove Avenue, Elgin, Illinois

Representatives in Principal Cities *In Canada: G. F. Sterne & Sons Ltd., Brantford*



DEAERATING HEATERS—supply make-up water pre-heated by exhaust steam in which CO_2 and oxygen are eliminated.

WATER FILTERS—Diatomite, sand, anthrafilt, activated carbon and oil removal filters in all types and sizes.

ACCO
for Better
Values

R-P&C VALVES

THE COMPLETE LINE
—DESIGNED FOR DEPENDABILITY

R-P&C "Sure-Tight" LUBROTITE GATE VALVES

—THE MULTI-SERVICE VALVES LUBRICATED THROUGH THE SEAT RINGS

Lubrotite Gate Valves—created and patented by R-P&C—are built to provide absolute tightness and long, trouble-free service in handling all fluids for which iron and cast steel valves are serviceable.

By the unique Lubrotite system, in which each seat ring is served by a Lubrotite gun, a lubricant seal is forced through to the valve's seating surface. This lubricant prevents leakage, retards corrosion, prevents sticking, reduces wear on seating surfaces and makes for easier operation. Net result: reduced operating, maintenance and over-all valve costs!

Available in cast steel and iron types. A wide variety of lubricant seals, each suitable for numerous services, can be furnished.

Lubrotite Gate Valves are giving highly successful service in handling—

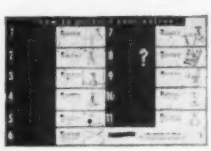
Gasoline...Oil...Benzol...HF Alkylation...
other Petroleum Derivatives —

Natural and Artificial Gas...Air...
Helium Gas...Coke and Gas...Water —

Vacuum Service (evaporation, etc.)...
Feed Water Lines and Steam Plants —

Mine and Acid River Waters...
Certain Chemicals...Other Services

Lubrotite Gate Valves form a part of the complete R-P&C line, which includes gate, globe, angle and check valves in all standard materials; all in a wide range of sizes, styles and pressure classes. Order through nearby R-P&C Distributor. Write our Reading office for catalog.



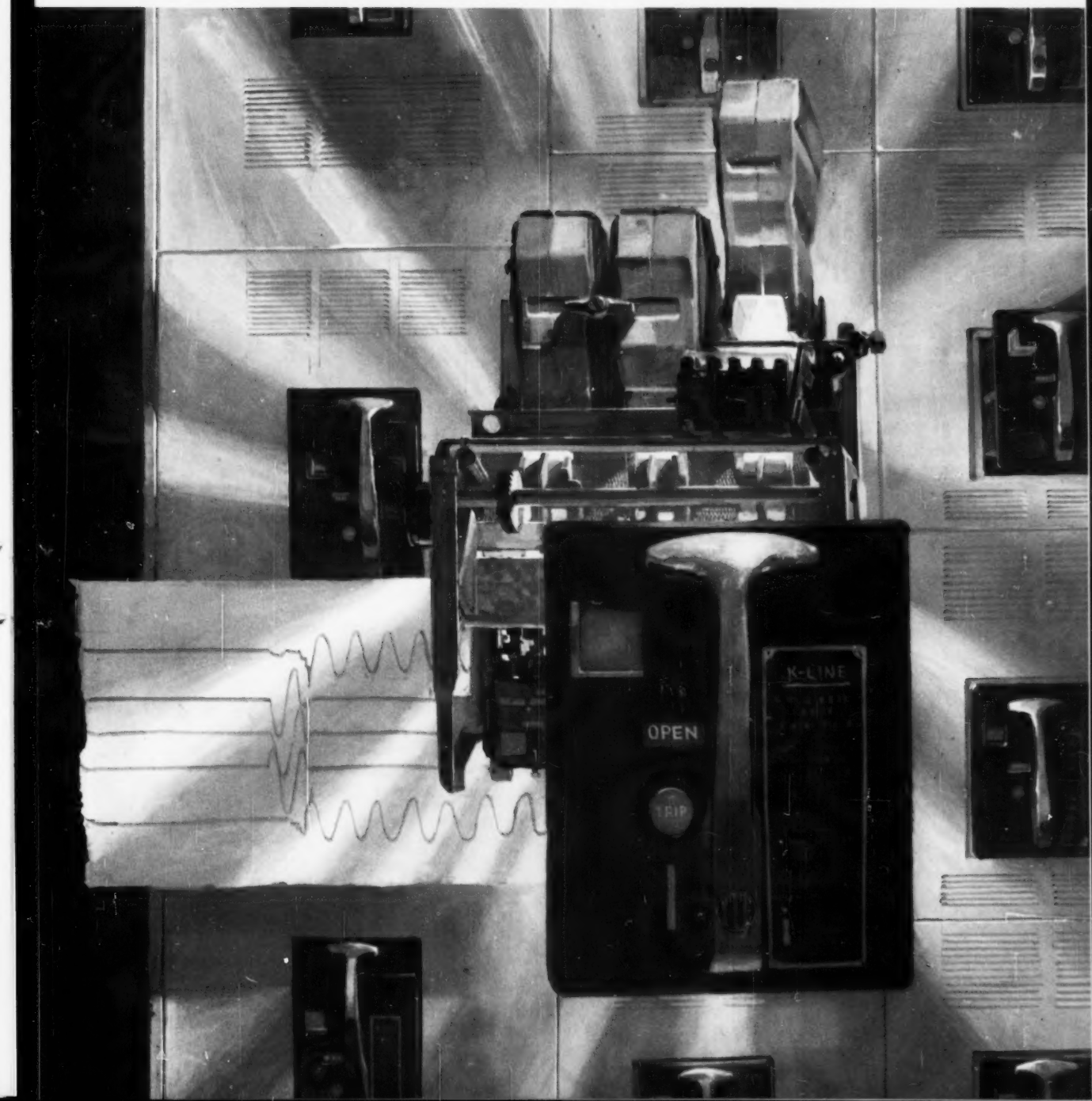
FREE WALL CHART
"How to Protect Your Valves"
Installation pointers, operating tips, clues to longer valve life. They are all on this 22" x 17" wall chart. Write for your free copy.

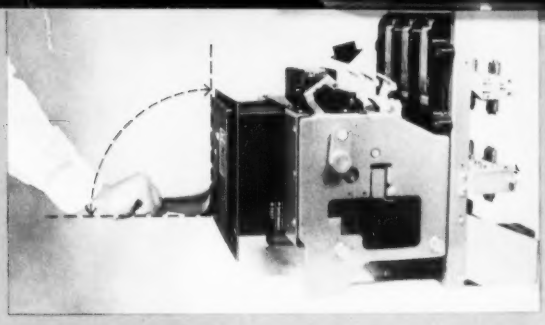
R-P&C VALVE DIVISION
AMERICAN CHAIN & CABLE

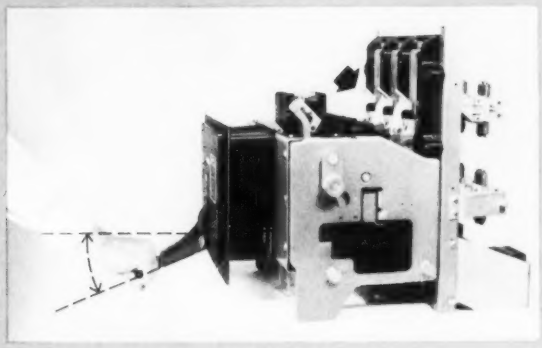
Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

ACCO

I-T-E new K-Line of low voltage switchgear represents the first major advance in this type of equipment in 13 years. This completely new design offers greatly increased safety and operating efficiency, is available in three frame size ratings: 225, 600 and 1600 amp continuous at 600 v alternating current.







Quick-make closure of contacts on manually operated circuit breakers is provided by spring action. The first 90% of the pulldown handle travel loads the springs, the last 10% releases the stored energy and closes the contacts. No teasing is possible.

I-T-E announces sweeping design advances in new line of low voltage power circuit breakers and switchgear

- First quick-make closure of contacts
- First closed-door racking of circuit breakers to any position
- First expanded range overcurrent trip device
- 4-high stacking of 600 amp frame size circuit breakers
- Subassembly construction of circuit breakers & accessories

Quick-make manual closure eliminates damaging arcing, greatly increases life of contacts and circuit breaker—contacts cannot be teased together, breaker cannot be destroyed by careless closing against a major fault.

Quick-make closure, formerly available only on electrically operated circuit breakers, now is a standard feature of all manually operated breakers in the new I-T-E K-Line.

A manually charged stored energy mechanism, powerful enough to close the contacts safely against a full short circuit, provides the manual quick-make action. The first 90% of travel of the new pulldown handle charges a set of springs, the last 10% of travel releases the stored energy and closes the contacts—breaker life and operator safety do not depend on the brawn and brain of the operator. Contacts cannot be teased together, the closing action is fast and positive.

Electrically operated models in the K-Line have an actuating motor in addition to the basic mechanism. This motor-driven, stored energy system requires only 10 amp from a simple power source, compared to as much as 160 amp by comparable solenoid mechanisms. Energy for closing is prestored by the new K-Line circuit breakers in 2 seconds. Closing time is 5 cycles.

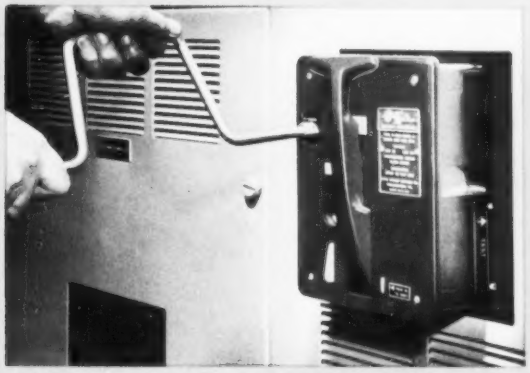
Closed-door drawout keeps circuit breakers clean and aisles uncluttered, promotes operator safety

This exclusive I-T-E feature permits racking of breaker into connected, test and disconnected positions without opening the door of the breaker compartment. It facilitates inspection, testing and maintenance. Blocked circuits are easy to identify. It keeps circuit breakers clean even in dust and dirt-laden atmospheres. It keeps aisles uncluttered and clear of compartment doors. It promotes personnel safety.

A lift shutter, which permits insertion of the racking crank that moves the breaker, can be padlocked in connected, test or disconnected position to guarantee complete safety. This shutter cannot be lifted while the circuit breaker is closed. Interlocking also prevents closing of the breaker while the shutter is lifted.

The extendible escutcheon slides through the compartment door while a dust seal surrounding the escutcheon is held in place by the door.

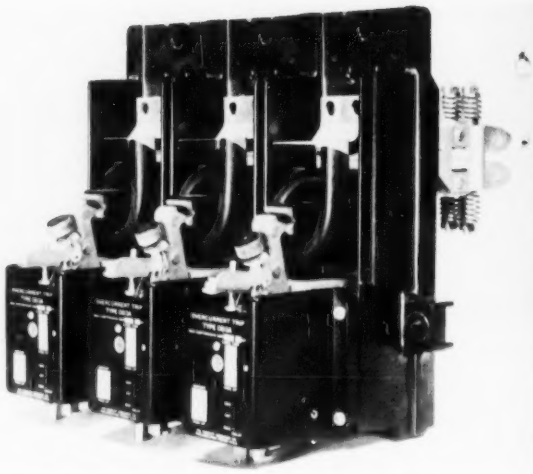
In addition to affording closed-door drawout, the new K-Line of switchgear is smaller than any comparable design. The reduced size of the circuit breakers permits 4-high stacking of 600 amp breakers. And unitized construction reduces the switchgear to three basic components —the breaker, the enclosure, and a cradle on which the circuit breaker rolls for drawout.



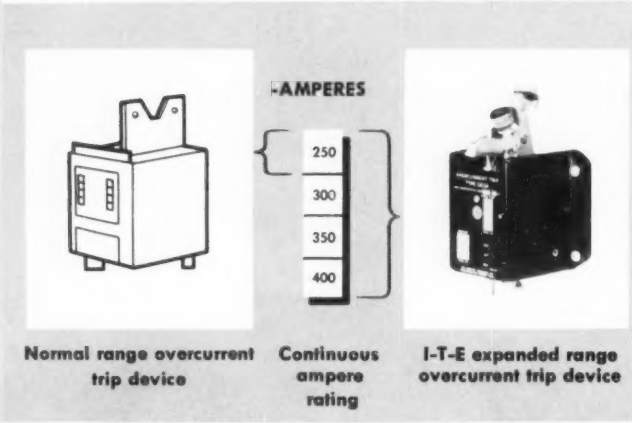
Exclusive closed-door drawout is illustrated in this series of photographs. Photo 1 shows shutter lifted and racking crank inserted. Photo 2 shows circuit breaker in connected position. Photo 3 shows breaker in test position. Photo 4 shows breaker in disconnected position.

New overcurrent trip arrangement permits use of each trip over wider range of continuous load conditions

Accessible trips, on both manual and electrical types, provide new ease of adjustment. Adjustment, a difficult job at best on previous electrical types, can now be made in a matter of seconds.



Common molding holds all three trips for this 600 amp K-Line circuit breaker. Can be replaced in a fraction of time required for changing the individual trips on comparable lines.



This table indicates a sample grouping of ratings for the new K-Line circuit breakers. Only 9 trip units now cover the range of continuous current ratings as against 23 formerly required.

Trip flexibility is an important feature of the K-Line. Only 9 trip units now cover the complete range of continuous current ratings—15 to 1600 amp—as against 23 formerly required. Last-minute changes in load capacity can be satisfied in many instances with the existing trip unit as a result of the expanded range of trip settings.

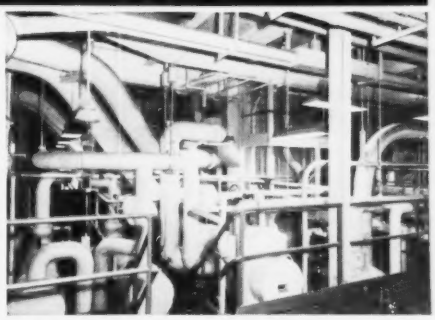
This feature, plus easy adjustment of trip devices and quick change in the field, is particularly significant in meeting constantly expanding load requirements. Trip units are mounted on a one-piece base. Trip units are changed from the rear and in a fraction of the time formerly required.

For the complete story of the I-T-E K-Line of circuit breakers and switchgear, see your local I-T-E representative. Or write us for Bulletin 6004C. I-T-E CIRCUIT BREAKER COMPANY, Switchgear Division, 19th & Hamilton Sts., Philadelphia 30, Pa.

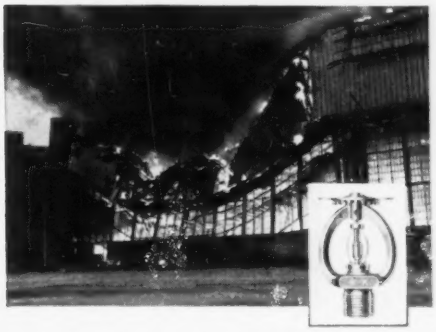
I-T-E CIRCUIT BREAKER COMPANY

19TH AND HAMILTON STREETS, PHILADELPHIA 30, PENNSYLVANIA

BLAW-KNOX has what it takes—to provide these products and services



Heater piping system in this modern generating station is typical of many high temperature, high pressure systems prefabricated and erected by Blaw-Knox. Experienced piping engineers, modern shop facilities and a new Blaw-Knox digital computer method for fast, accurate calculation of piping stresses are available to you. Let us know your requirements and we'll provide the service you need. For more information, write for Bulletin No. 2443—"Piping for Industry."



Out of every 100 firms who lose their records in a fire, 43 never reopen for business. Be safe. Let a Blaw-Knox fire-protection engineer study your needs—and explain how you can pay for the system on our lease or deferred payment plan. To get more information send for Bulletin No. 2426—"Fire Can Destroy Your Business."

Blaw-Knox trapeze functional spring hanger installed in first large atomic generating station. Vital power piping system for the atomic generating unit in the Duquesne Light Company's Shippingport Station is supported by Blaw-Knox custom-engineered hangers.

Blaw-Knox makes a complete line of standard and custom-engineered pipe hangers, supports, and vibration eliminators. Each is a complete packaged unit, designed for a specific purpose and constructed to comply with the "code for pressure piping." Available in types and sizes to meet varying conditions, ready to install.

Blaw-Knox engineers, who have solved many difficult hanger and piping vibration problems, are always available to both design and make recommendations for your hanger requirements. For further information, write for Catalog No. 54.

BLAW-KNOX

BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

829 Beaver Avenue • Pittsburgh 33, Pennsylvania

Complete facilities for prefabrication and erection of piping systems for all pressures and temperatures ... complete line of standard and custom-engineered pipe hangers, supports and vibration eliminators ... complete line of automatic sprinkler systems for standard and special hazards

How To Make Your FIRST Buy

Rockwell-Edward forged steel inclined

WELDED BONNET CAN'T LEAK

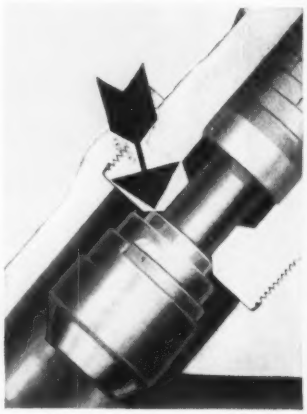
Seal-welded body-bonnet joint maintains pressure tightness in any service. Weld easily removed for disassembly. Threaded section and body shoulder carry pressure load and give accurate alignment. Exclusive Impactor handwheel, shown here, available only on 2½ in. size.

HARD-FACED INTEGRAL SEAT

Continuous Stellite ring (arrows) applied to body and disk retains hardness at high temperature; resists corrosion and erosion. Stellited seat is precision-machined in same set-up as body bore, then carefully lapped to form drop-tight mated seating surfaces.

TIGHT BACKSEAT SAVES PACKING

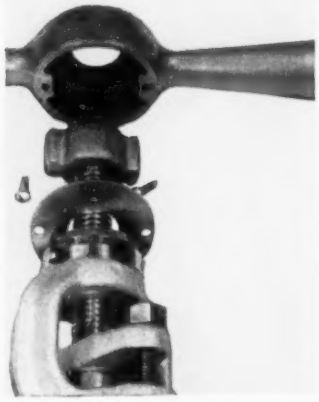
Radiused disk nut contacts plane beveled surface at the bottom of the bonnet, gives high load line contact capable of penetrating oxidation to create complete isolation of packing chamber from line pressure. This minimizes maintenance, increases packing life.



CROSS ARM IMPACTOR* HANDLE

Now the famous Edward Impactor principle is applied to the larger forged steel Univalves. Delivers 2.8 times the closing load of ordinary handwheels. Assures tight seating with minimum effort in minimum space. Knobbed easy-grip handwheel on smaller size Univalves.

*T M. Reg. U.S. Pat. Off.



WIDE RANGE OF USES

For steam, water, oil or gas: wherever pressure and/or temperature demand a dependable high-pressure valve the Univalve will do the job best. One line of standard valves will perform all drain, vent, bypass, blow-down, instrument take-off and all but the most difficult throttling functions. Shown here is a pair of Univalves used for boiler blow-off service.

STREAMLINING CUTS FLOW RESISTANCE

Inclined stem and internal streamlining cut turbulence, reduce pressure drop, minimize wear. Edward scientists incorporate precise streamlining in every Edward valve. Wood dowel through bore of this Univalve demonstrates straight-through design.

Rockwell-Built Edward Valves

The RIGHT Buy In Steel Valves

stem Univalve* is a good example . . .

The original cost of steel valves is often only the *beginning*. Frequently, on the heels of installation, comes a series of repairs (involving cost and service interruption) ending in premature replacement. How much *less* costly it is, in terms of cash and down-time, to buy steel valves which are "right"—right from the start.

This isn't always easy. Some valves scream "price", others assert "quality" without defining what they mean. It remains for Edward, long-time leader in the field, to step forward with a word of quiet assurance.

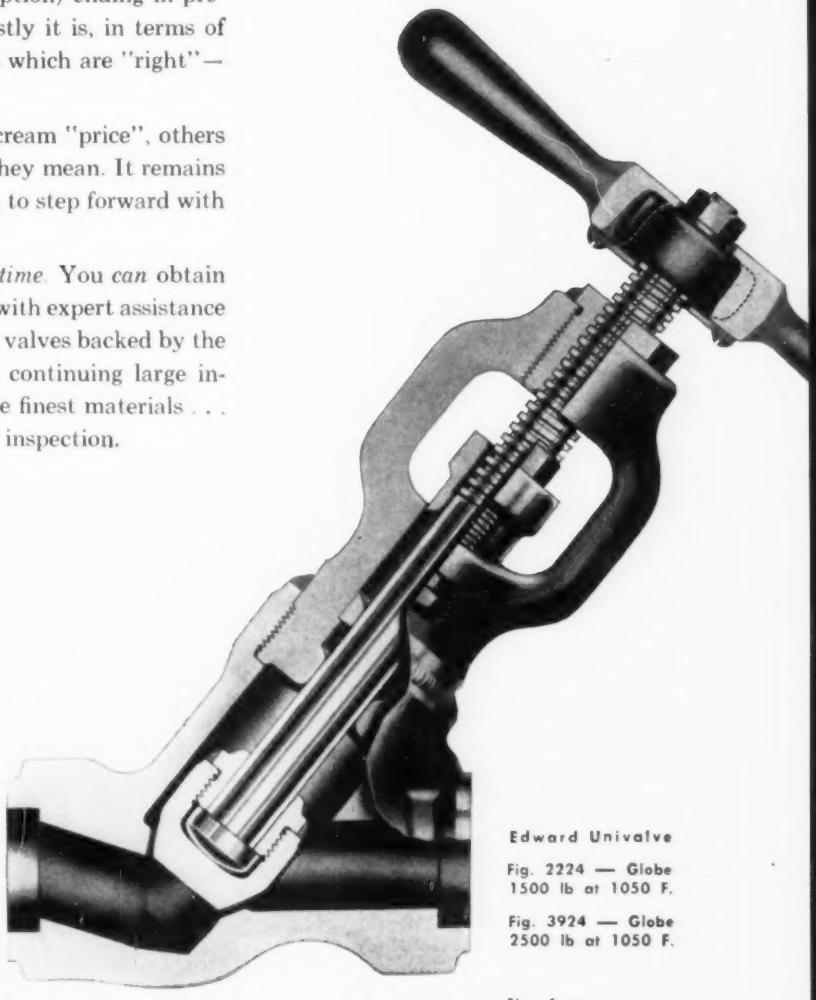
It *is* possible to "buy right" the *first time*. You *can* obtain steel valves exactly right for your needs, with expert assistance every step of the way. You can be *sure* of valves backed by the Edward reputation . . . the company's continuing large investment in valve research . . . use of the finest materials . . . and the most careful craftsmanship and inspection.

UNIVALVE A GOOD EXAMPLE

Edward valves do not cost substantially more than competitive valves. But they give you a *great deal* more for your valve dollar. A case in point is that of the Edward inclined stem Univalve* pictured on these pages. At right, it appears in entirety; at left, upon the facing page, are a half-dozen of the premium features you will find in this valve. They invite your attention.

We respectfully suggest a visit from your Edward Representative. Technically trained, thoroughly experienced, his professional advice can save you headaches and money. There is no obligation, of course. Whether you are interested in steel valves for original installation or for replacement, it will pay you well to get in touch with us *today*.

*T.M. Reg. U.S. Pat. Off. — — Integral seat valves, with body and bonnet a single unit



Edward Univalve

Fig. 2224 — Globe
1500 lb at 1050 F.

Fig. 3924 — Globe
2500 lb at 1050 F.

Sizes from
¼ in. to 2½ in.

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1230 West 145th Street, EAST CHICAGO, INDIANA

Here's Why . . .

You Save With Silicone Insulated Outdoor Motors for Power Stations

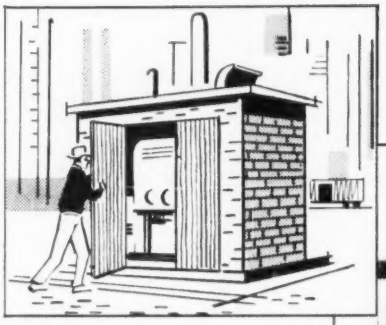
Silicone insulation is establishing a trend toward less costly enclosures for auxiliary drive motors in power stations. By readily withstanding moisture and contaminants circulated in ambient air, Dow Corning silicone insulation makes possible more open enclosures and lower cost per horsepower.

Leading electrical equipment manufacturers already offer complete lines of silicone insulated "all-weather" motors in ratings from 100 to 5000 horsepower.

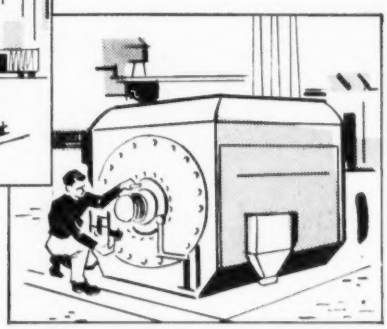
Safe, reliable operation outdoors the year 'round is assured by Dow Corning silicone insulation. Experience has shown silicone insulated motors readily withstand torrential rains, hurricane winds, corrosive fumes, fly ash, dust, salt air, snow, sleet, cold, heat — even flooding.

Extra overload capacity is provided by the silicone insulated windings. As a general rule, silicone insulation offers a 50% greater service factor and lasts at least 10 times longer than Class B insulation under similar operating conditions. That's why for the most dependable auxiliary drive motors, it's wise to

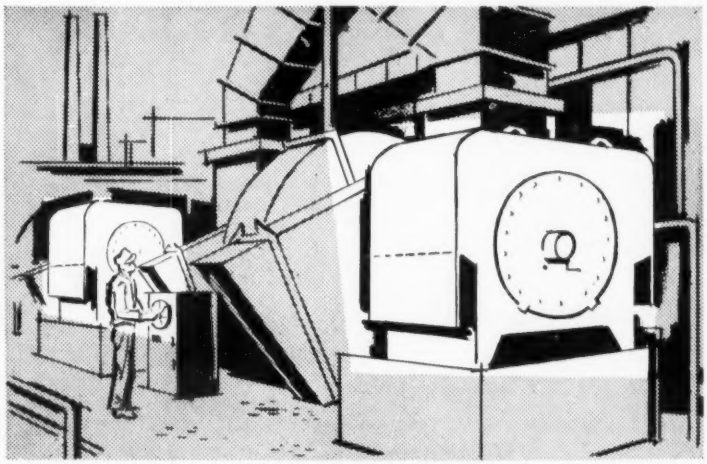
Specify DOW CORNING SILICONES and *Save*



Initially, motors were sheltered in buildings . . .



Later, motor enclosures themselves sealed out surrounding atmosphere



Now, silicones protect motor parts permitting the circulation of ambient air . . . lower-cost enclosures.

first in silicones

Dow Corning CORPORATION

MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C.

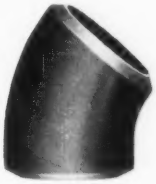
World's First Nuclear-Powered Surface Ship will have MIDWEST Welding Elbows

U. S. Navy's guided missile, nuclear-powered cruiser "Long Beach"

OFFICIAL U. S. NAVY PHOTOGRAPH

Special Fittings are "ROUTINE" for Midwest

Stainless Steel
S.R. 102° Elbow
with tangent on one end.



Stainless Clad
S.R. 39° Elbow
with tangent on one end.

Stainless Steel
S.R. 90° Elbow
with tangent on both ends.

Special Elbows (dimensions, tangents, wall thicknesses and materials) are easily provided by the exclusive and flexible Midwest method. Elbows are available in any material that can be secured as plate, which also means better delivery. Closer tolerances are inherent in the Midwest process. Quality control always exceeds Code requirements.

Shown here are three of the special stainless steel and stainless-clad elbows made by Midwest for the "U.S.S. Long Beach". All reactor coolant piping must meet extremely rigid specifications because of the difficult service. Special quality controls, such as ultrasonic testing, intergranular corrosion tests, dye checking, radiography, and ring flattening tests were used one or more times at various stages of manufacture from the raw material to the finished fittings. Special quality standards for soundness of metal, "water clear" welds, dimensional accuracy, and surface finish were satisfied.

The U. S. Navy's first nuclear-powered surface ship, the "Long Beach", will introduce a radically new concept in defense capabilities. She will operate offensively and independently of other forces under conditions of both nuclear and non-nuclear warfare against airborne, surface or under-sea opposition. In addition to equipment and weapons for detecting and destroying enemy submarines, she will carry the Navy's modern guided missiles.

The piping for the atomic reactors being designed and developed by the Westinghouse Electric Corporation will use a large number of special heavy wall stainless steel Midwest Welding Elbows. This is not the first atomic project for which Midwest Welding Fittings have been used. In fact, when the nuclear propulsion program first began, Midwest furnished special welding fittings for the "Nautilus" prototype installation at Arco, Idaho.

Whether or not you are concerned with nuclear power, Midwest Welding Fittings (both stock and specials) will do a better job for you. Ask your Midwest distributor or write us for Catalog 54, which tells you why.

MIDWEST PIPING COMPANY, INC.

Main Office: St. Louis 3, Missouri (P.O. Box 433)

Plants: St. Louis, Clifton, N. J. and Los Angeles

SALES OFFICES: ASHEVILLE (BOX 446, SKYLAND, N.C.) • BOSTON 27—426 FIRST ST.
CHICAGO 3—79 WEST MONROE ST. • CLEVELAND 14—616 ST. CLAIR AVE.
HOUSTON 2—1213 CAPITOL AVE. • LOS ANGELES 33—520 ANDERSON ST.
MIAMI 34—2103 LE JEUNE RD. • NEW YORK 7—50 CHURCH ST.
PITTSBURGH 19, PA.—437 GRANT ST. • ST. LOUIS 4—1450 S. SECOND ST.
SAN FRANCISCO 11—420 MARKET ST.
STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

7918

MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

For The Ultimate in FLY ASH COLLECTION Be Sure It's...

WESTERN PRECIPITATION *First* in Electrical Precipitators

Power plant operators who want the finest equipment available for fly ash collection will find nothing to equal the long life, high efficiency and low maintenance of *Western Precipitation* Electrical Precipitators.

The reason is simple – No other electrical Precipitator is backed by so many years of leadership in the field – nor incorporates so many outstanding advantages pioneered by the industry's most experienced organization in the development of Cottrell equipment – experience beginning with the world's first commercial Cottrell installation!

This cross-section of a typical Western Precipitation Electrical Precipitator shows a few of the many important details that go into the construction of these units...

CONSTRUCTION FEATURES

▶ Arrangement of curtains (1), baffles and hi-voltage wires (2) assures optimum uniformity of electrical field – therefore maximum collection efficiency.

▶ Baffles (3) insure minimum dust reentrainment and optimum gas distribution.

▶ Curtains and hi-voltage system are engineered for maximum stability, even distribution of rapper impact, and unequalled ease of installation.

▶ No moving parts in the gas stream.

▶ Supports (4) for hi-voltage system are specially designed to resist side thrusts, and require minimum maintenance.

▶ Internal stiffeners permit clean, smooth external surfaces for easy insulation (5).

▶ Air-swept insulator compartments (6) insure long life, minimum maintenance.

▶ Unobstructed free-flowing hoppers (7) permit complete dust evacuation.

ADVANCED RAPPER DESIGN

▶ Frequency and intensity of rapping is variable over wide ranges to eliminate puffing and meet individual operating requirements.

▶ All rappers (8) are external for easy adjustment and maintenance.

▶ Flexible mounting – either side or top.

SAFETY ENGINEERED

▶ Hi-voltage insulators (9) are protected by separate compartments with individual access (10).

▶ Quick-opening access (11) doors are positive-sealing.

▶ Complete interlock system available at minimum cost.

"TRANSISTOMATIC" PRECIPITATOR CONTROL

▶ No tubes, no relays, no moving parts – *carries lifetime guarantee!*

▶ *Infinitely* variable precipitator voltage to suit operating conditions.

▶ Automatically compensates for line voltage fluctuations.

Before finalizing plans for installing any dust or fly ash collection equipment, get the full story on the finest collection equipment available – Western Precipitation Cottrells!

WESTERN PRECIPITATION CORPORATION

Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

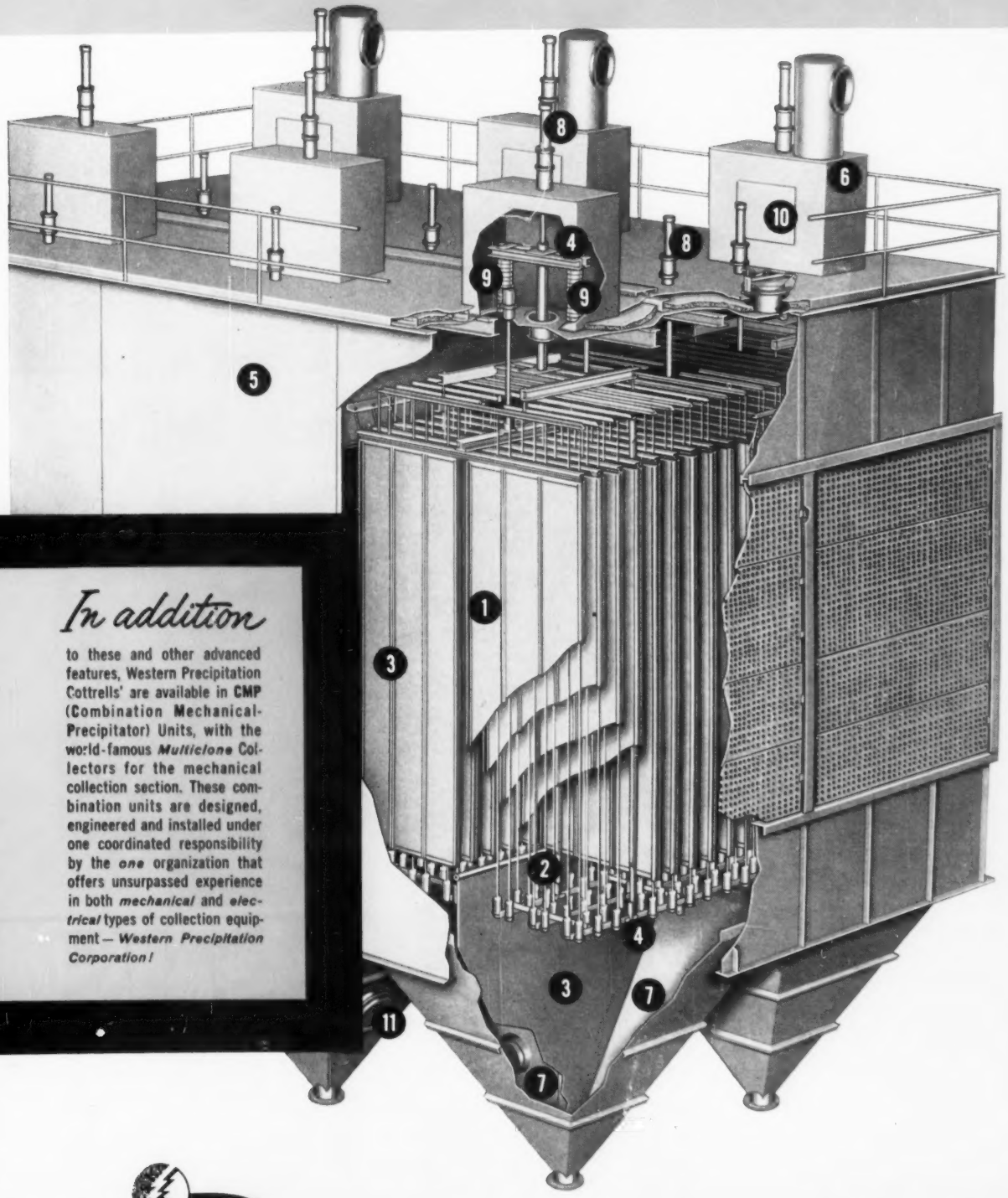
LOS ANGELES 54 • NEW YORK 17 • CHICAGO 2 • PITTSBURGH 22 • ATLANTA 5 • SAN FRANCISCO 4

Representatives in all principal cities

Precipitation Company of Canada Ltd., Dominion Square Bldg., Montreal

The only equipment backed by a

Half-Century of Cottrell Experience



In addition

to these and other advanced features, Western Precipitation Cottrells' are available in **CMP** (Combination Mechanical-Precipitator) Units, with the world-famous ***Multiclone*** Collectors for the mechanical collection section. These combination units are designed, engineered and installed under one coordinated responsibility by the ***one*** organization that offers unsurpassed experience in both ***mechanical*** and ***electrical*** types of collection equipment— ***Western Precipitation Corporation!***

REMEMBER—*in the field of dust collection, nothing equals the long life, low maintenance and high collection efficiency of a Cottrell Electrical Precipitator!*

ASCO Remote Control Switches and Transfer Switches assure dual protection for Lincoln Tunnel.

Light or power failure in the Lincoln Tunnel or on its highway approaches could have disastrous consequences – for thousands of cars and trucks pour through the underwater throughway every day. This is why engineers selected ASCO Remote Control Switches and Automatic Transfer Switches in several strategic locations.

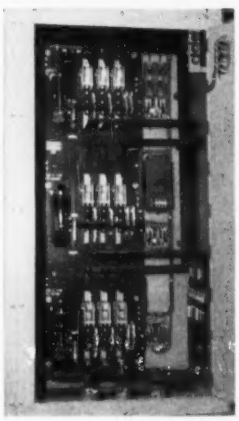
ASCO REMOTE CONTROL SWITCHES help provide the proper voltages to tunnel lighting and adjacent highway lighting. Triple interlocked ASCO Remotes are used for switching the primaries of transformers feeding 800, 1000, 1200 volt fluorescent lighting circuits. Three lighting circuits are required because of the starting characteristics of two fluorescent tubes in series. On cold days, 1200 volts are required to "strike the arc" across a pair of fluorescents. On warm days, only 800 volts are needed. An additional benefit – higher voltages can compensate for lamp aging. Check these advantages of ASCO Remote Control Switches:

• Standard listings in capacities from 30 to 1000 amperes; available to 750 volts AC or DC • Available to 24 poles, single or double throw • Mechanically Held, Electrically Operated . . . unaffected by line voltage conditions; respond only to push buttons. Insure against outages on vital circuits caused by momentary line voltage drops.

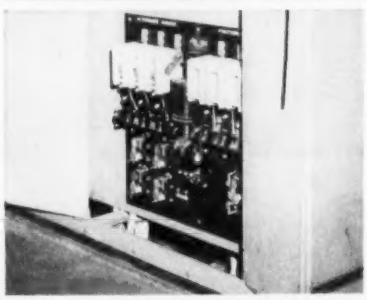
ASCO TRANSFER SWITCHES, specified in many other applications where power is vital, guarantee continuous power to such vital services as tunnel pumps, control rooms, and fire alarm systems. They feature these basic advantages of ASCO Transfer Switches:

• continuous duty rating in either normal or emergency position • capacity to withstand inrush currents 20 times full load rating • mechanical locking, providing sure contact pressure • single coil design • built-in time delay, so that equipment ignores harmless momentary outages • accessories to meet your specific requirements • full phase protection and other design features.

Write for Catalog 57-S2 on ASCO Remote Control Switches – for Booklet 596 describing how to select an adequate automatic transfer switch – or for Catalog 57-S1 on ASCO Automatic Transfer Switches.



Triple interlocked Bulletin 911-163S Remote Control Switches are used for switching the primaries of transformers feeding 800, 1000 and 1200 volt fluorescent lighting circuits.



Typical ASCO Bulletin 906-166 Automatic Transfer Switch provides auxiliary power for the circulating pump, the sewage ejector, the sump pump, the essential service bus and the control room.

Automatic Switch Co.
54-1 Hanover Road, Florham Park, New Jersey
FRontier 7-4600

ASCO®

Valves for Power Plants

Fig. 1314 A—1500-Pound Integral bonnet steel "Y" Valve.

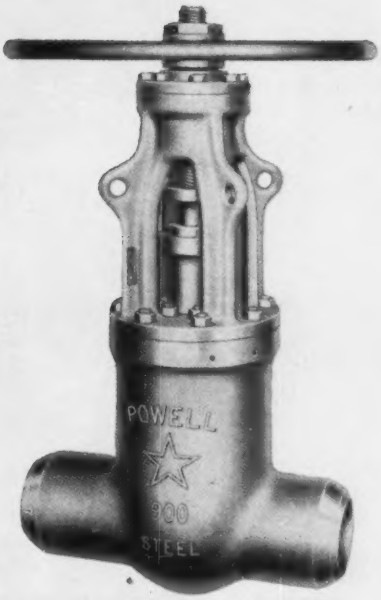


Fig. 19003—Powell Steel Pressure Seal Gate Valve for 900 pounds W.S.P.

Fig. 375—Bronze Gate Valve for 200 pounds W.S.P. Union bonnet, inside screw rising stem.

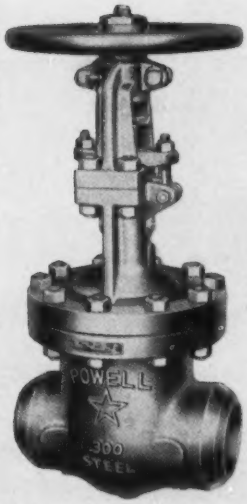


Fig. 3003 WE—Steel Gate Valve for 300 pounds. Outside screw rising stem and yoke.

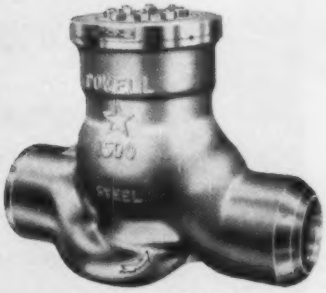


Fig. 11365—Steel Pressure Seal Horizontal Lift Check Valve for 1500 pounds.

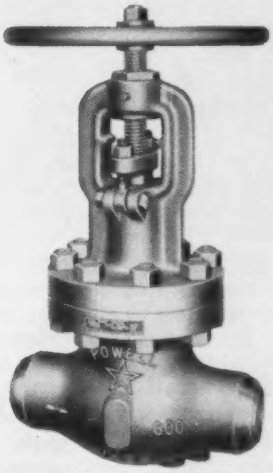


Fig. 6031 WE—600-Pound Steel Globe Valve for steam service. Outside screw stem and yoke.

POWELL...
world's largest family of valves

FOR EVERY FLOW CONTROL PROBLEM Powell offers more kinds or types of valves, available in the largest variety of metals and alloys, to handle every flow control requirement. Your local valve distributor will be glad to tell you all about them. Or write to us for the full facts.

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

Kw Capacity GOING UP

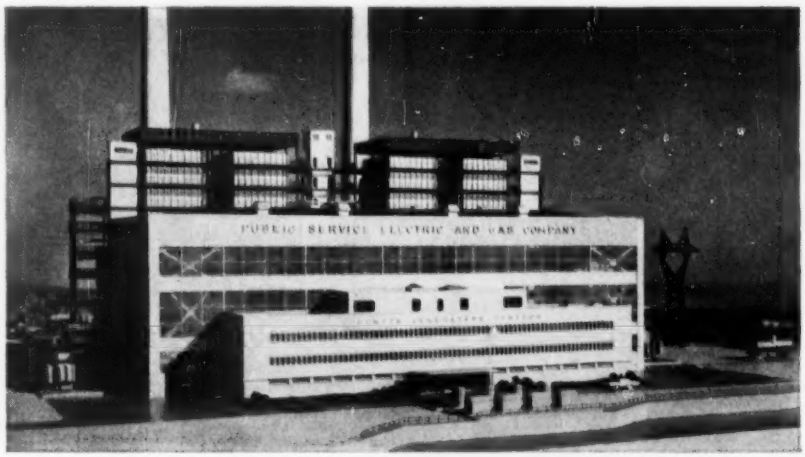
for PUBLIC SERVICE ELECTRIC AND GAS COMPANY

New Bergen Generating Station will add 580,000 kw to The Public Service system— and Units No. 1 and No. 2 will both be served by FW double-furnace reheat steam generators of 1,900,000 lb/hr capacity

THE GREAT postwar growth of New Jersey's industry and suburbs has placed heavy demands upon the power capacity of Public Service Electric and Gas Company. To keep ahead of this rapidly growing demand, Public Service has embarked upon a construction program which will amount to approximately $345,000,000. An important segment of this expansion program is the construction of the new Bergen Generating Station, in Ridgefield, which will have an output of 580,000 kw — increasing system capacity by 27½% over that of December 31, 1956. The station will consist of two generating units of 290,000 kw each and is scheduled for service in the early part of 1959.

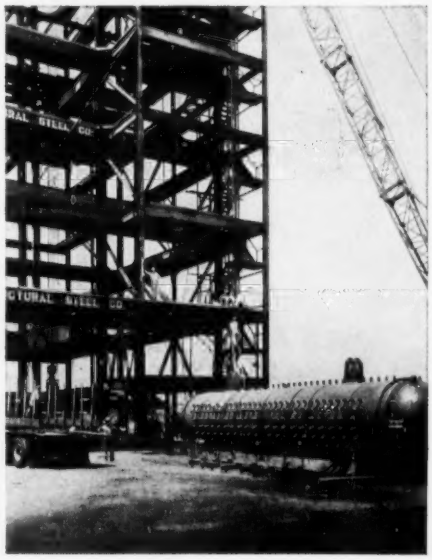
Both units at the Bergen Generating Station will be served by Foster Wheeler steam generators — each generator providing 1,900,000 lb of steam per hour at a design pressure of 2,725 psig. Primary steam temperature will be 1100 F with reheat temperature of 1050 F. The units are of double-furnace, natural circulation design and are fueled by pulverized coal. They are constructed for pressurized operation, utilizing forced draft fans only.

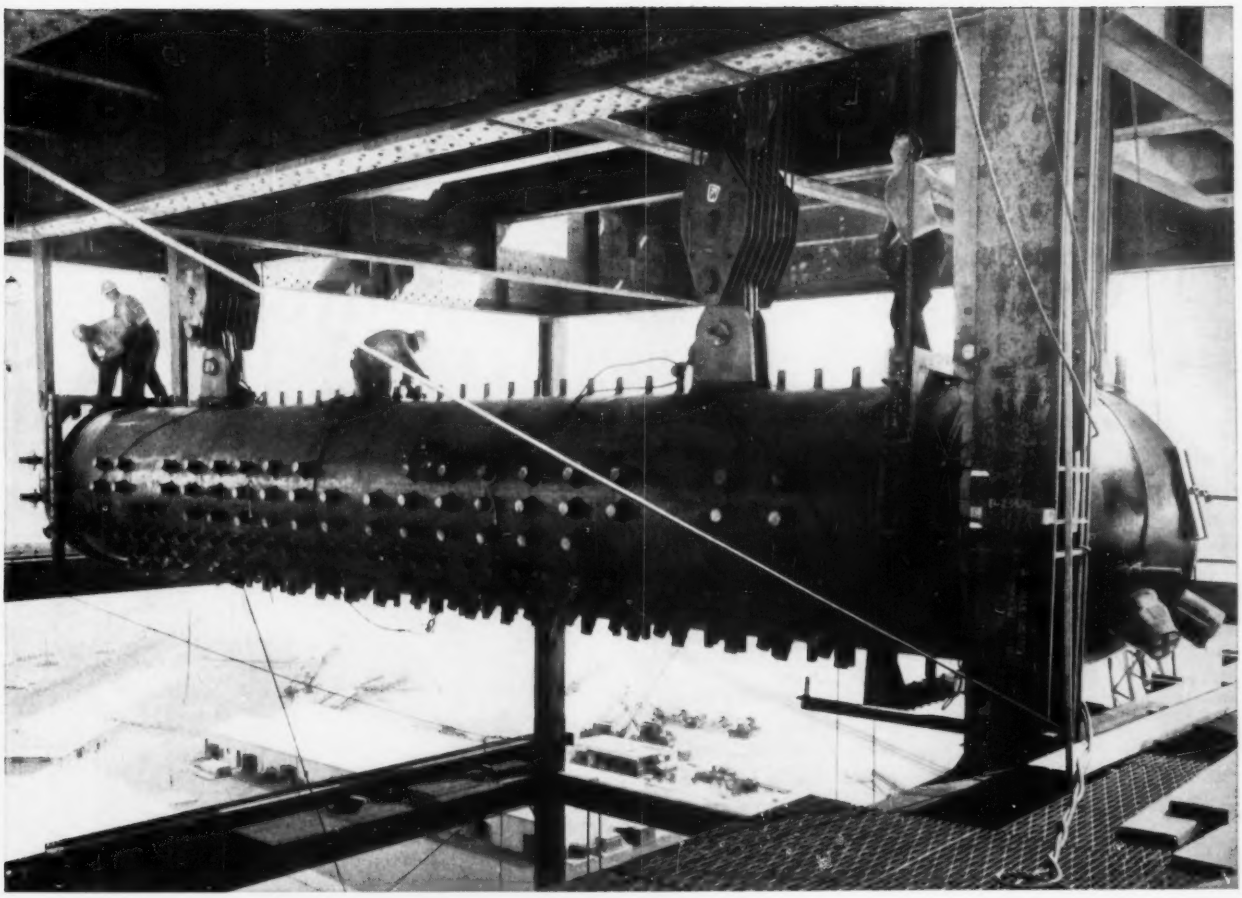
In addition to the steam generators Public Service has also ordered six

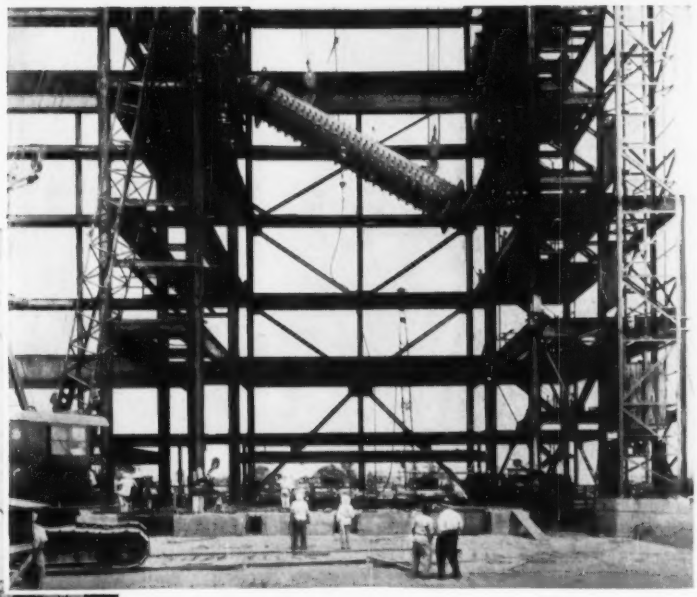


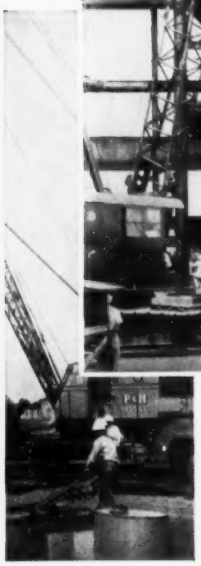
FW ball mill pulverizers — three for each unit. With capacities of 81,000 lbs of coal per hour each, they are the largest ball mills manufactured by FW to date.

With more than a half-century of experience in steam generation — and the finest modern manufacturing facilities in three large plants—Foster Wheeler welcomes the opportunity to quote on your requirements. You'll receive the same kind of heat engineering experience and service that led Public Service Electric and Gas Company to award Foster Wheeler its part of the Bergen Generating Station.









The photographs at left and above show three stages in the process of hoisting the 125-ton steam drum into erected position in the FW steam generator for Unit No. 1 at the Bergen Generating Station of Public Service Electric and Gas Company. The generator will supply 1,900,000 lb of steam per hour at 2,725 lb/sq in gage design, 1100 F primary steam temperature and 1050 F reheat temperature.

Both of the units at Bergen are expected to go into service early in 1959.

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

YOU CAN SAVE... time, labor and money BY CONVERTING your hand-operated valves...

TO LimiTorque®

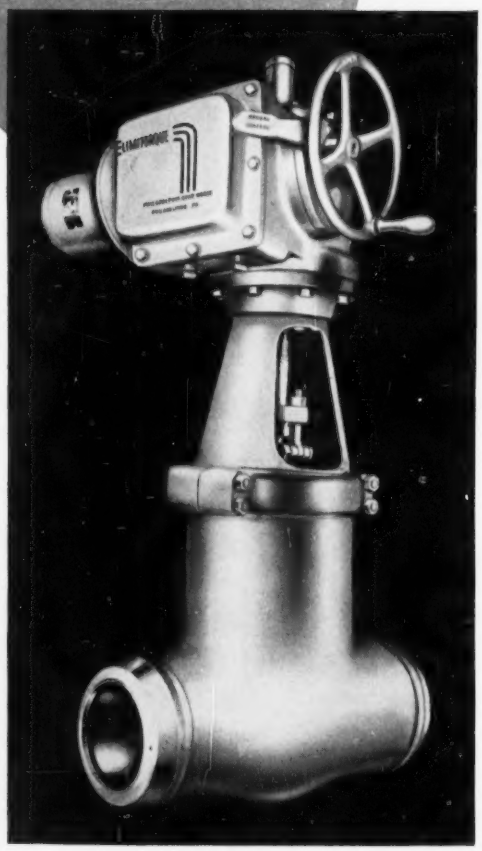
Trouble-Free Motorized Valve Operation

Why not be modern and thrifty too,—follow the example of hundreds of plants of all types. *Convert* your present hand-operated valves to LimiTorque "push-button control"—*save time, labor and money.*

In most instances, LimiTorque conversion requires only minor changes to the valve. Your LimiTorque Valve Operators can be furnished as a completely packaged unit including electrical controls and push button. Simply wire the power leads to your source of electricity.

With LimiTorque, one finger does the work of many hands, by permitting key personnel to operate, and know the exact position of each valve from a centrally located control panel.

In addition, LimiTorque protects seats, discs and stems from damage, by automatically shutting-off power source should an obstruction interfere with valve closing. LimiTorque-operated valves are always seated tightly because the valve disc seating thrust is accurately maintained in each closing-cycle, through a micrometer-adjusted torque limiting mechanism.



LimiTorque can be field-mounted on your existing valves—contact your valve manufacturer or nearest LimiTorque sales-engineering office.

Send for complete new Catalog L-550, on your business letterhead.

LimiTorque®

PHILADELPHIA GEAR WORKS, INC.
ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

They packed up turbine oil worries at Alton Box Board

six turbines use NONPAREIL Turbine Oil, have life-of-turbine guarantee

Six NONPAREIL Turbine Oil guarantee certificates on the turbine room wall are pointed out by M. D. Jones, Superintendent of the Power and Steam Department. Standard Oil Company's lubrication engineer, W. P. "Sandy" Wehking, helped put most of the certificates there.

Alton Box Board Company, Alton, Illinois, doesn't have a worry in the world about turbine oil. The Company has six turbines in service—four in the power plant and two in the paper mill—all using NONPAREIL Turbine Oil. Why no worries? Because each of these fills of turbine oil is *guaranteed for the life of the turbine* not to exceed a neutralization number above 0.15 mg. KOH/g.

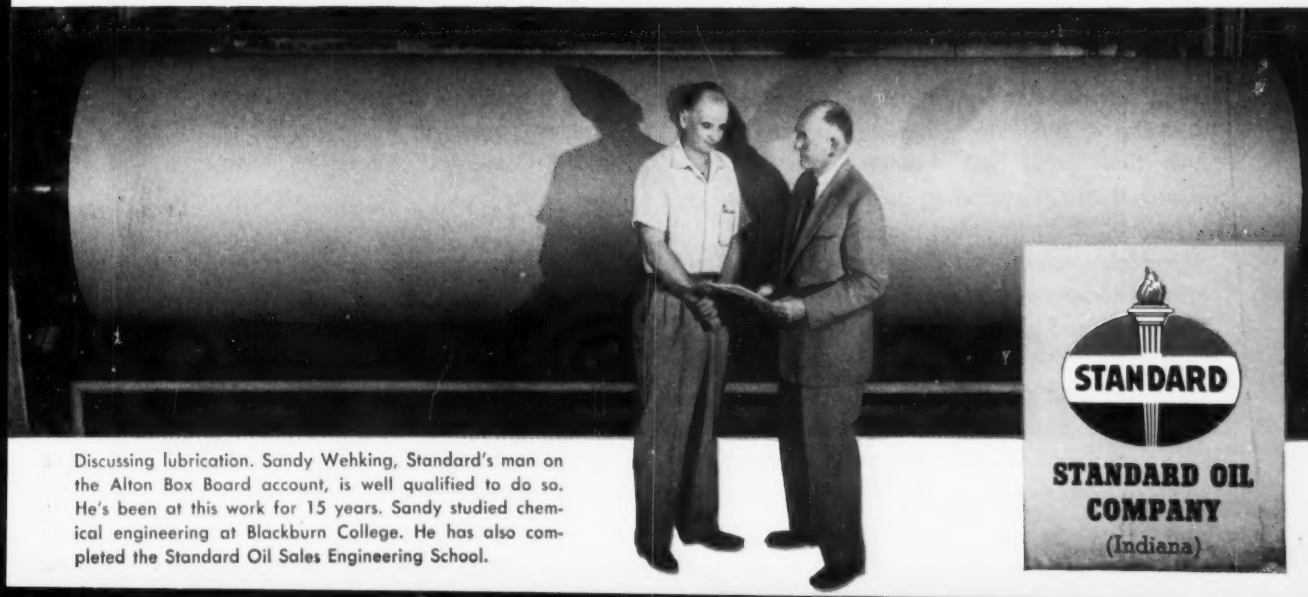
The five Westinghouse and one G-E turbine oil fills have demonstrated a remarkable low acidity record over the years. Regular inspection by Standard Oil technical service representatives and analysis of oil samples by the Standard Oil Research Laboratory, Whiting, Indiana, makes sure the oil is performing in accordance with the guarantee. At Alton Box, neutralization number of the oil has been running 0.02 to 0.03 mg. KOH/g.

This is what such service from a turbine oil means to Alton Box Board: They can run one of the largest board mills in the world without having to concern themselves with the performance of the turbine oil they are using. Standard Oil technical service men inspect the system. The oil is sampled and analyzed regularly. Plant operation will never be interrupted because of turbine oil lubrication failure.

The same performance from NONPAREIL Turbine Oil and service from Standard Oil awaits you. Find out. Call your nearby Standard Oil office near you in any of the 15 Midwest and Rocky Mountain states. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

How NONPAREIL Turbine Oil is performing at Alton Box Board

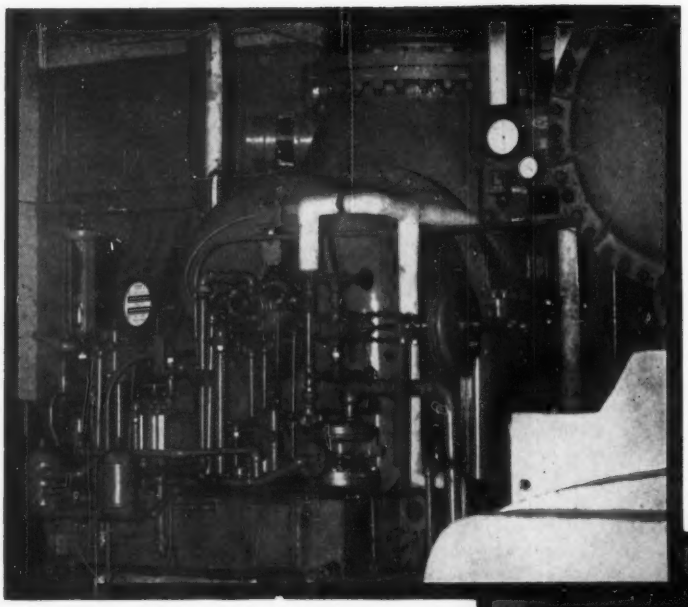
Make of Turbine	kw. (H.P.)	Year NONPAREIL Installed	Location	Gal. fill.	Neut. No. mg. KOH/g.
Westinghouse	1,500	1934	Power Plant	85	.02
Westinghouse	3,125	1936	Power Plant	275	.03
General Elec.	400	1936	Paper Mill	50	.02
Westinghouse	1,500	1941	Power Plant	250	.03
Westinghouse	5,000	1947	Power Plant	230	.03
Westinghouse	1,500	1947	Paper Mill	80	.02



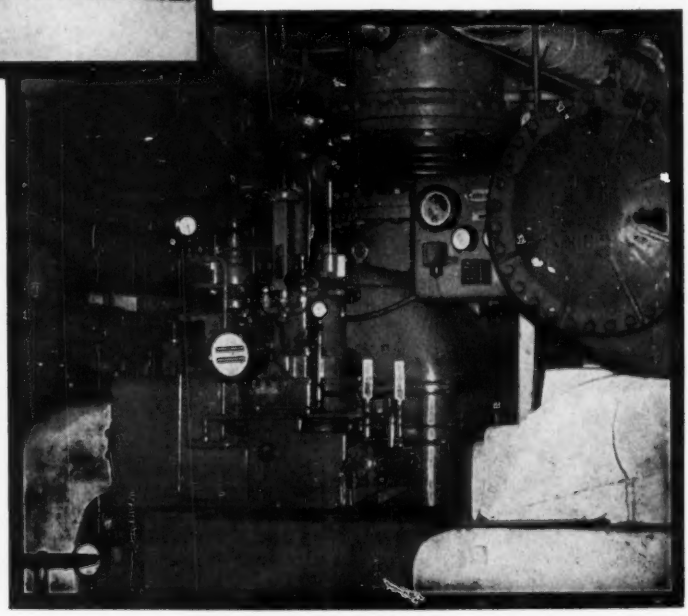
Discussing lubrication. Sandy Wehking, Standard's man on the Alton Box Board account, is well qualified to do so. He's been at this work for 15 years. Sandy studied chemical engineering at Blackburn College. He has also completed the Standard Oil Sales Engineering School.

STANDARD

STANDARD OIL COMPANY (Indiana)



1948—For air conditioning drive B. Altman & Co. installed a Murray low pressure turbine providing 633 HP at 5010 RPM.



1950—Again B. Altman & Co. selected Murray to drive another air conditioning unit with a 905 HP, 3880 RPM low pressure turbine.

ALTMAN'S SCAVENGES LOW PRESSURE STEAM FOR AIR CONDITIONING DRIVE

B. Altman & Co. in New York City are utilizing low pressure steam to power the air conditioning of their large department store at 34th Street and Fifth Avenue. Economical Murray turbines operating on exhaust steam at only 2# gauge pressure provide the smooth dependable power for the store's two centrifugal compressors. Your low pressure steam can be utilized just as effectively to drive any type of machine. Murray's low pressure turbines are developing as much as 2200 HP in a single turbine and of course Murray's long experience assures you af an added plus value of service and long life.

Consult your local Murray representative who will be pleased to show you ways of utilizing your low pressure steam. MURRAY IRON WORKS COMPANY, Burlington, Iowa.

★★ **Murray Turbines** ★★

ANKORITE

Black Water-proof Tape

IS

WATER-PROOF ALKALI-PROOF
ACID-PROOF ABRASION-PROOF
WEATHER-PROOF

ANKORITE BLACK WATER-PROOF TAPE is a heavy, sticky, black insulating tape, rubber free. In service, Ankorite Black Water-proof Tape splices perform a duplex function; the inner turns remain soft, adhering to the wire in a sticky insulative coating, while the outer layers fuse into solid sheath absolutely impervious to water and air.

Weather-proof and Water-proof qualities are at first glance a distinct advantage in tape which is designed exclusively to meet outdoor conditions. This Tape is free from rubber, thus assuring the user against gradual vulcanization or hardening of the tape through age.

Abrasion-proof qualities are frequently necessary in a tape for exterior use. The toughness of the compound and the strength of the fabric used in our tape insure this quality.

Acid-proof and Alkali-proof qualities become important in underground work. The viscous, bituminous base of Ankorite Black Water-proof Tape is resistant to the natural acid and alkali solutions found in mine water.

In addition, Ankorite Black Water-proof Tape is noncorrosive, nonravelling and free from pin holes.

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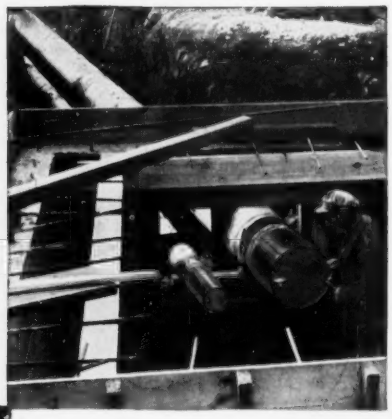
FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

MR. ENGINEER:

LET'S FACE THE FACTS . . .

How can an underground piping system be watertight when you can't *AIR TEST* it?



Test caps applied to unit ends for air testing full-welded conduit system.

WITH

RIC·WIL

During air test, conduit field welds are checked with soap solution.

Tested and ready for lowering long lengths.

YOU can AIR TEST your system...

The RIC-WIL method of making full-welded field closures allows the installer to AIR TEST the system prior to completion and backfilling. This simple 15 lb. pressure test gives greater assurance of a tight, leak-proof system. It provides the finest practicable protection to the owner against an initial system failure ...and most important, the long range effects of water corrosion.

Ask a RIC-WIL field representative for detailed information regarding Air Test procedure or write for catalog covering recommended field installation details . . . and remember, it pays to do it RIGHT the first time . . .

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency
SINCE 1910

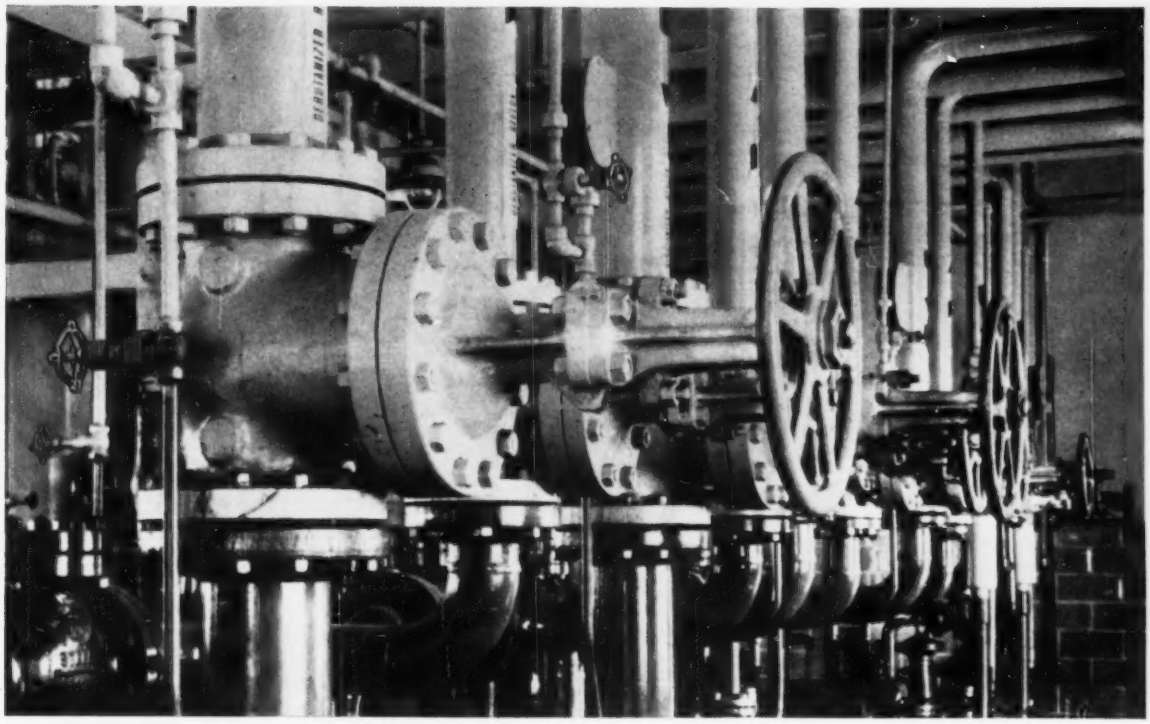
RIC·WIL INCORPORATED — PREFABRICATED INSULATED PIPING SYSTEMS

BARBERTON, OHIO

IN CANADA: THE RIC-WIL COMPANY OF CANADA LIMITED

Don't Hedge on Quality When You Buy Steel Valves...

Maintenance costs can gobble up your savings in a few months!



LUNKENHEIMER QUALITY is no longer a luxury—it's your vitally needed insurance against today's sky-high maintenance expense. Labor rates are going still higher . . . "downtime" costs are multiplying . . . repair charges are rocketing up—with no relief in sight. Today, it pays to buy the *best valves you can get*, with no hedging on quality. Your purchase of Lunkenheimer Steel Valves is an investment that pays worthwhile dividends in maintenance savings . . . year after trouble-free year. The Lunkenheimer Company, Box 360, Annex Station, Cincinnati 14, Ohio.

The cost of a LUNKENHEIMER VALVE
Gets smaller...and smaller...and smaller...
with each passing year af dependable service

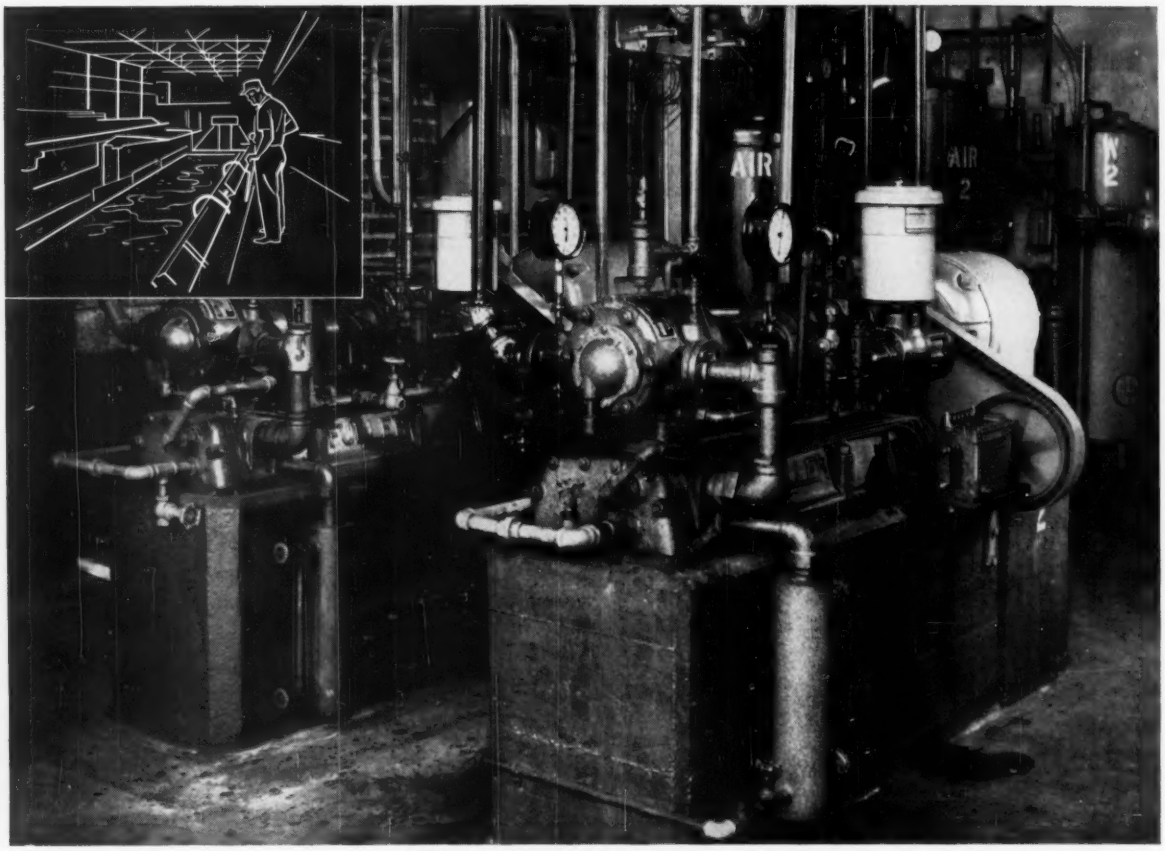
A check on the cost of maintaining your cast steel valves will prove this point.

STEEL • BRONZE • IRON • PVC

L-1086-2

LUNKENHEIMER QUALITY

LUNKENHEIMER®
THE ONE *Great* NAME IN VALVES



These two-stage Fuller Rotary Compressors are direct electric motor driven through flexible couplings to provide compressed air for a large eastern steel company.

5 YEARS WITHOUT A HITCH!
. . . FULLER Rotary Compressor
helps keep steel plant operating around the clock!

Compressed air is so vital in the alloy tube division of this large eastern steel company, that the plant would have to shut down without it!

The chief maintenance engineer of the company writes: "The first Fuller Rotary Compressor was purchased on the basis of experience by other users and cost comparison with other compressors.

"The second Fuller Rotary Compressor was purchased on the basis of the fine performance given by the first compressor. The most outstanding feature of Fuller Rotary Compressors is that they give trouble-free continuous operation".

Fuller rotary compressors can be installed in limited quarters and on ordinary flooring. They give long life and smooth operations. The elimination of valves, crankshafts, pistons and other moving parts greatly reduces the need for attention, adjustment and replacement. Blades are held out by centrifugal force, automatically compensating for wear, thus maintaining new machine efficiency and capacity. The rotary principle permits a design completely free of reciprocating parts, avoiding the basic cause of pulsation.

There is a Fuller Rotary Compressor to fit your particular needs. Write today for complete details.

Fuller

FULLER COMPANY GENERAL AMERICAN TRADE MARK

"See Chemical Engineering Catalog for details and specifications."

Visit us at the National Plant Maintenance and Engineering Show, Chicago, January 27-30 Booth No. 959-961

FULLER COMPANY C-324 4915

126 Bridge St., Catasauqua, Pa.

SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION

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PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

Fabri-Seal Insulation Failure Investigated

Introduced by Elliott in 1948. Achieved 8-year field service record. First failure occurred in 1957. Causes investigated by Elliott engineers.

The Elliott Company, which takes pride in the service record of its stator coil insulation for large induction motors, had some explaining to do this fall when its much-publicized Fabri-Seal insulation experienced its first failure.

Fabri-Seal insulation was introduced in 1948, installed in motors serving utilities and industries all over the country. According to Elliott's Ridgway sales management, "these motors shattered all previous field service records with not one insulation breakdown in over 8 years." Then in late 1957 the first failure occurred. Elliott engineers were quick to launch an investigation to determine what had happened to spoil such a splendid record.

Over 1,900,000 hp installed

An analysis of the tabulated field service records confirm that since 1948 more than 1,900,000 hp of Elliott's large motors with Fabri-Seal insulation were put into service and that none of them experienced an insulation breakdown in nearly 9 years.

Briefly, this insulation system includes sealing of coil slot sections with hand-wrapped Mylar*-backed mica, plastic-sealing at vulnerable points, vacuum preconditioning and pressure impregnation, turn-to-turn testing at high surge voltages, immersion of the complete stator in insulating varnish and subsequent baking. Obviously, it also involves new materials and fabrication methods, as well as thousands of man-hours tabulating and analyzing accelerated life-testing of hundreds of insulation systems.

Not one electrical failure in over 8 years

The fact that not one of these machines experienced an insulation failure in over 8 years was prominently exploited in literature, advertisements and in personal contacts. At the height of this promotion the first Fabri-Seal insulation failure occurred. After recovering from the initial shock, the sales management was quick to point out—and rightly so—that a failure had to happen sooner or later and that this did not in any way nullify the 8-year field service record.

First insulation failure occurred in 1957

The insulation failure occurred in a motor serving a Gulf Coast chemical plant. Elliott engineers hastened to the scene and found that the atmosphere was laden with highly-corrosive, hygroscopic magnesium chloride dust.

When this corrosive dust blanketed the winding, it absorbed moisture to an almost unbelievable extent. Failure occurred right after a torrential downpour deluged the area with 11 in. of rain in a 24-hour period, bringing the humidity in the area near 100%. Although the weather-protecting enclosure kept out the rain, the magnesium chloride with its water-absorbing action literally "sucked" the moisture out of the air onto the coils.

"In effect," the engineers reported, "the motor has been operating in a brine solution, practically the equivalent of being submerged. Furthermore, the corrosive dust had attacked the paint, steel baffles, and even brass name plates."

It must be said, however, that at no time did the Elliott engineers blame the failure on the severity of the operating conditions. At the same time, they were still not convinced that Fabri-Seal insulation was at fault. In their opinion, Fabri-Seal coil insulation *simply would not fail*—even in such highly-corrosive and moist atmospheres.

How Elliott engineers solved the problem

With the customer's permission, the motor was returned to the factory for further investigation. After careful examination, Elliott engineers announced that "the motor revealed irrefutable evidence of faulty materials and workmanship,"—quite an embarrassing thing to have to admit.

"Our only consolation," Elliott engineers reported," was that this failure occurred in what our customer described as 'the world's most severe insulation application' where every major make of motor has been installed . . . and has failed in less than one year of operation."

The Elliott Company promptly rewound the stator coils with Fabri-Seal insulation, gave all mechanical parts additional treatment for corrosive conditions and returned the motor to the customer for service.

Although this failure broke the continuous service record that started in 1948, Elliott sales management reported that, "it did not reveal any basic weakness in the Fabri-Seal Insulation System."

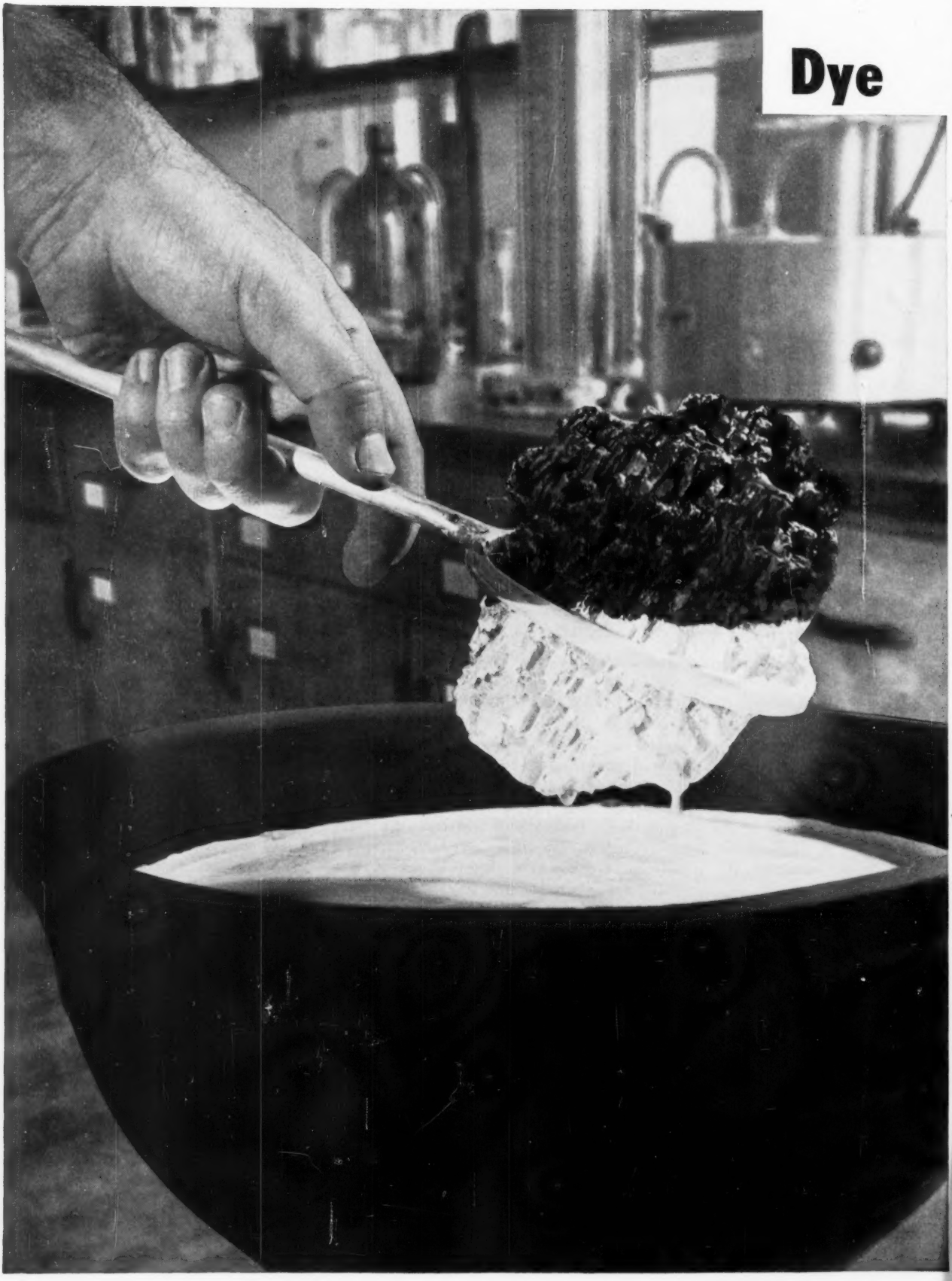
Elliott's continuous insulation research

Even while Elliott Fabri-Seal insulation was establishing the 8-year field service record, Elliott engineers were busy life-testing a new Super-Fabri-Seal insulation. The results of these tests forecast a new era in large motor service life. They were made over a period of nine years, are now being tabulated and complete details will be released at an early date.

*Dupont Trademark

ELLIOTT Company

Ridgway Plant, Ridgway, Pa.


Dye

maker brightens fuel cost picture

Burning coal at Toms River-Cincinnati saves 20% on fuel costs, permits clean steam generation

The Toms River-Cincinnati Chemical Corp. plant in Toms River, N.J. is the most modern plant of its kind in the world. Producing vat dyestuffs requires a large dependable steam supply for chemical processes and heating purposes. To fill these requirements, the power plant at Toms River-Cincinnati is as up-to-date and efficient as the general plant itself. The fuel used for steam generation is *coal* because, on the basis of cost per thousand pounds of steam, the nearest competitive fuel costs 20% more than coal. In addition, thanks to automatic operation and modern equipment, the power plant meets the rigid standards of cleanliness required in such manufacturing operations.

Facts you should know about coal

Not only is bituminous coal the lowest-cost fuel in most industrial areas, as in the case of Toms River-Cincinnati, but up-to-date coal burning equipment can give you 10% to 40% more steam per dollar. Today's automatic equipment pares labor costs and eliminates smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

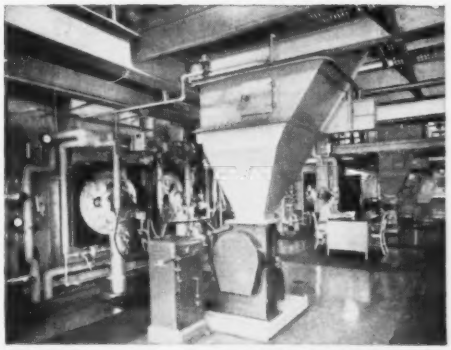
The Bituminous Coal Institute offers a free technical advisory service on industrial fuel problems. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send for our case history booklet, complete with data sheets. You'll find it informative.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—will effect great savings for you in efficiency and fuel economy over the years.

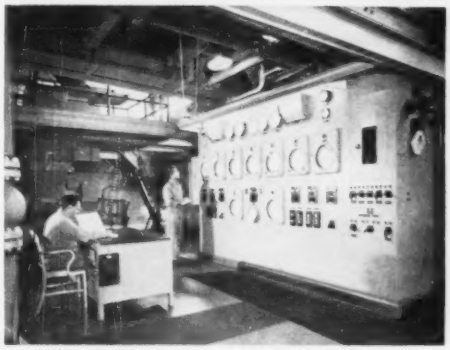
BITUMINOUS COAL INSTITUTE

Southern Building • Washington 5, D. C.

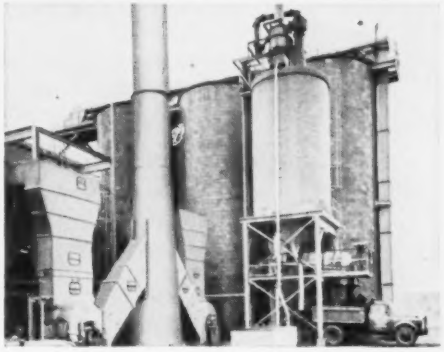


View of boiler room showing both 50,000 lbs. hr. boilers, by Riley Stoker Corp. Each has two burners. Center foreground is automatic weigh scale, by Richardson Scale Co., which receives coal through hopper from live storage bin and passes it to coal feeder. Coal is fed to Riley Pulverizer in basement, then blown back up to burners.

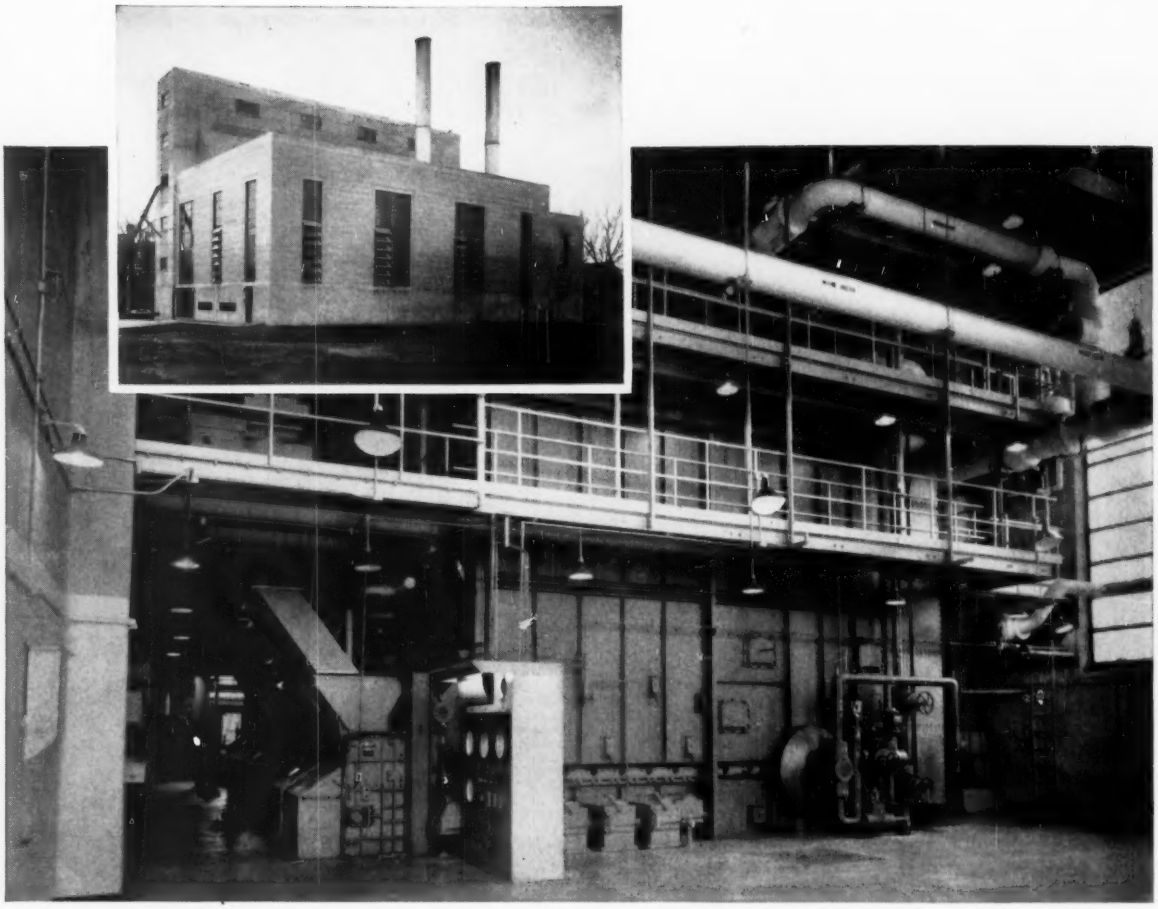
Close-up of Gifford-Wood Roundabout Bucket Conveyor beneath coal storage silos. Transversing feeder-car is used when coal is emptied from silo and conveyed to live storage bin.



Automatic combustion control and instrument panel by Bailey Meter Co.



Fly ash being loaded on truck through a dustless rotary unloader. Fly ash is collected by Prat-Daniel Mechanical Precipitators. A pneumatic ash collecting system by United Conveyor (with tie-ins under air heater and at base of stack) removes it to this 20-ton ash silo. In the rear are three 330-ton coal silos.



Union Boilers stretch fuel dollars at Mendota State Hospital

A dependable steam supply with low steam generating costs plays a key role in the efficient operation of the Mendota State Hospital. Occupying 384 acres near Madison, Wisconsin, it houses 900 patients and 491 employees in 40 buildings. To reach the furthest point of service, steam travels over half a mile from the power plant.

Carrying the load is a pair of Union 2-drum VO Type Steam Generators. Individually rated at 50,000 lbs./hr. at 165 psi, both units are fired with traveling grate stokers, and together, burn 12,000 tons of coal annually. Since the day this Union Boiler duo was installed, the hospital has enjoyed uninterrupted steam service.

At many institutions as well as industrial and public power plants, careful consideration of long term steam costs has been an important factor in the choice of Union boilers. Over 67 years of experience in steam generation stands behind their proven performance.

GET FULL DETAILS on how Union Steam Generators can stretch your fuel dollars. Available for oil or gas firing, they're built in many sizes and types to meet a wide range of steam requirements. Write for illustrated Catalog GB-153.

UNION

UNION IRON WORKS

ERIE, PENNSYLVANIA

O-B VALVES

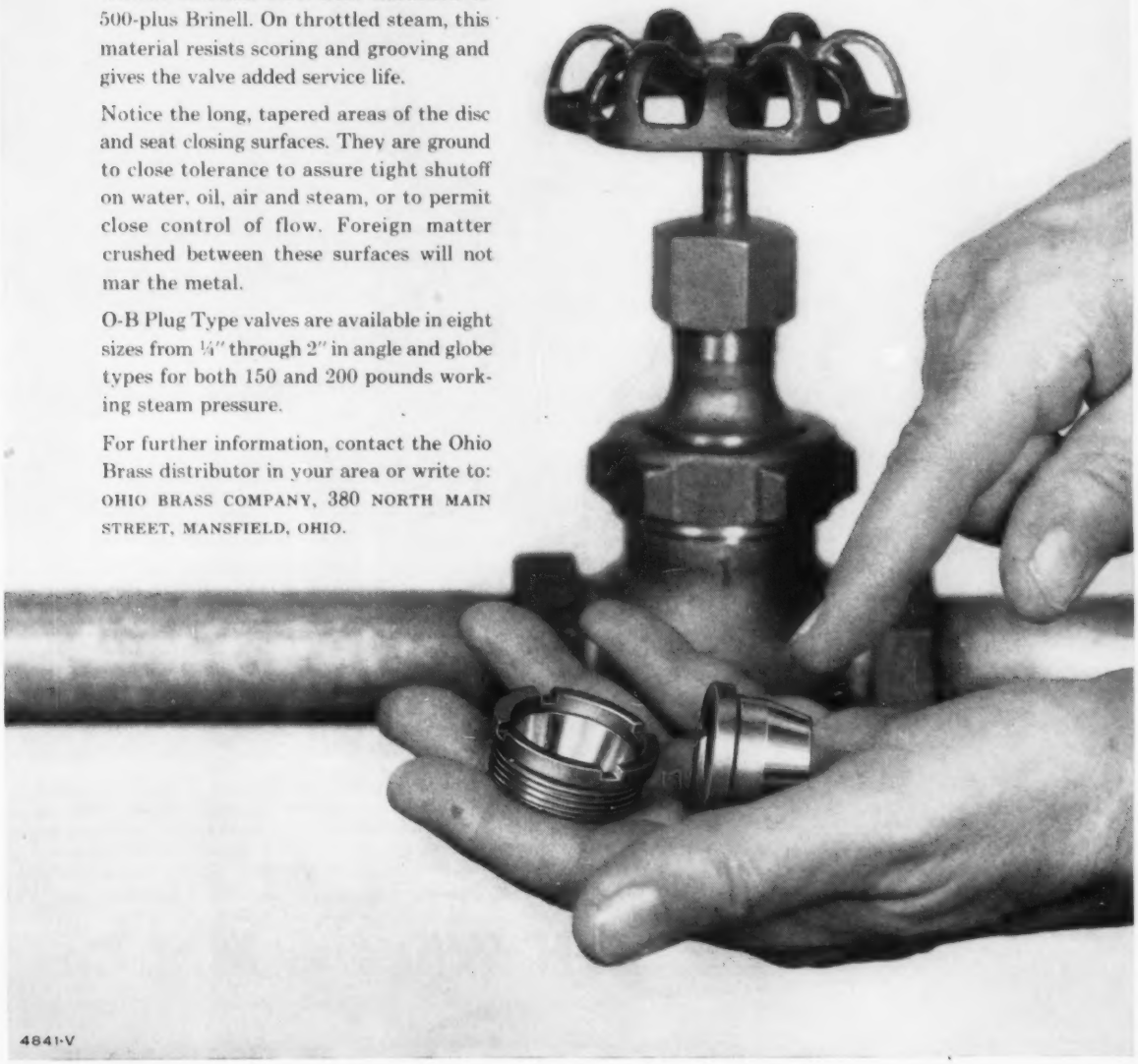
when throttling steam . . . use stainless steel seat and disc

The O-B Plug Type valve is made for tough throttling jobs . . . especially the throttling of steam. Seat and disc are chrome stainless steel heat hardened to 500-plus Brinell. On throttled steam, this material resists scoring and grooving and gives the valve added service life.

Notice the long, tapered areas of the disc and seat closing surfaces. They are ground to close tolerance to assure tight shutoff on water, oil, air and steam, or to permit close control of flow. Foreign matter crushed between these surfaces will not mar the metal.

O-B Plug Type valves are available in eight sizes from ¼" through 2" in angle and globe types for both 150 and 200 pounds working steam pressure.

For further information, contact the Ohio Brass distributor in your area or write to: OHIO BRASS COMPANY, 380 NORTH MAIN STREET, MANSFIELD, OHIO.



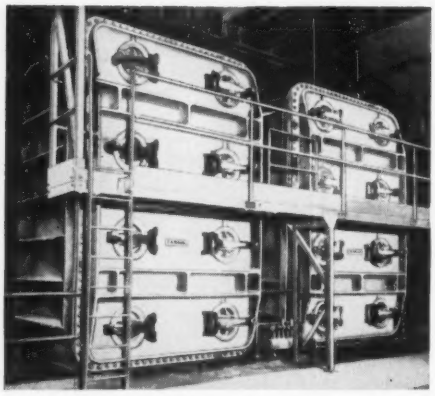
4841-V

Before you place your next order...

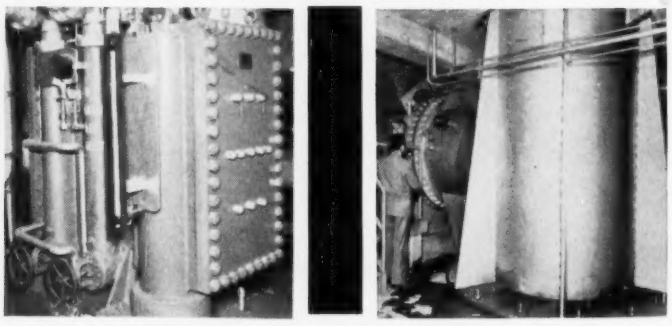
It's saved many weeks, even months of engineering and executive time for scores of power companies! Basically, the idea is to shift as much of the work load as possible from the customer to C.H. Wheeler. By working this way, long conferences are replaced by short phone calls, and lengthy customer-prepared engineering specifications are supplanted by thumbnail performance sheets.

Since Wheeler specializes in designing and building condensing equipment, its Engineering Department is set up to take this bare minimum of data from the customer, and work up a comprehensive proposal from it alone. Here you see several department heads of C. H. Wheeler discussing engineering design prior to preparing a proposal for a C. H. Wheeler client.

Discover C. H. Wheeler's time-saving way to buy steam condensers



We often save clients up to 4 months' time by sending Wheeler engineers to work "on the board" at clients' offices, instead of mailing drawings for approval. Above is a typical installation—a 105,000 sq. ft. Dual Bank Divided Water Box Unit, installed at a New York station.* It condenses 950,000 lbs. steam/hr.



Other C. H. Wheeler power plant equipment includes steel-shell "Tubejet"® Air Ejectors (left) as installed at eastern plant*, Circulators (right) which in the same plant deliver 86,500 gpm water, and Condensate Pumps. See your representative or write for details on the time-saving way to buy Dual Bank Surface Condensers and other power equipment.

**Names of these and other power stations equipped by C.H. Wheeler supplied on request.*

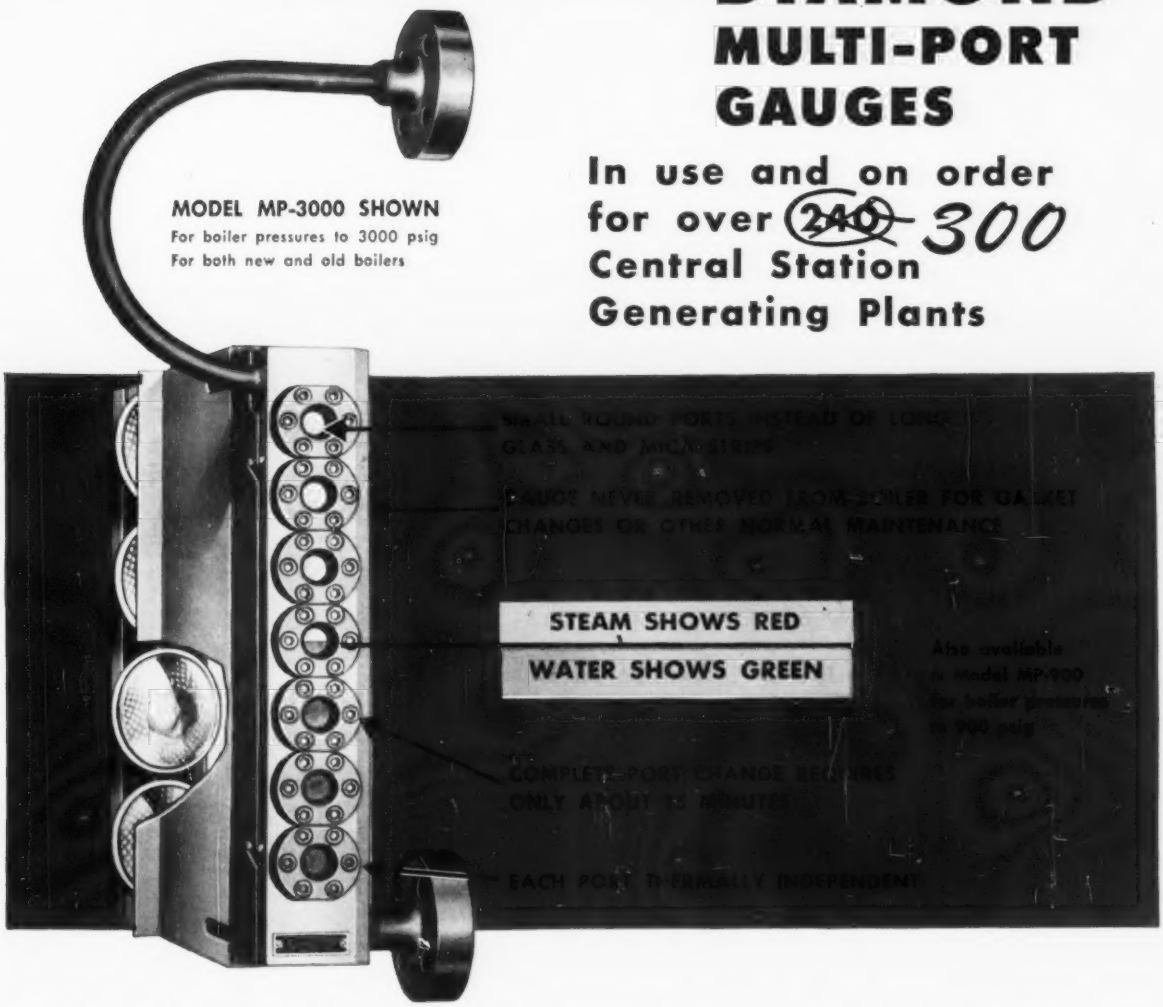
C. H. Wheeler Mfg. Co.

19TH & LEHIGH AVENUE Philadelphia 32, Pennsylvania

Steam Condensers • Vacuum Equipment • Centrifugal, Axial and Mixed Flow Pumps • Marine Auxiliary Machinery • Nuclear Products

MORE THAN ~~950~~ 1400 DIAMOND MULTI-PORT GAUGES

In use and on order for over ~~240~~ 300 Central Station Generating Plants



Because the Diamond Multi-Port solves the problems inherent in water level gauges on boilers operating at high temperatures and pressures, it has had rapid and wide acceptance. In addition to the 1400 for central station generating plants, more than 150 have been sold to industrial power plants.

Advantages of the Multi-Port are many. In addition to those shown above, it has maximum thermal stability for rapid starting . . . "Hi-Lite" illuminator for improved readability . . . welded construction for permanent tightness . . . end stems can be furnished instead of flanges . . . startling reductions in maintenance costs.

Write for Bulletin 1174U (Model MP-3000) or Bulletin 2044U (Model MP-900) for more information.

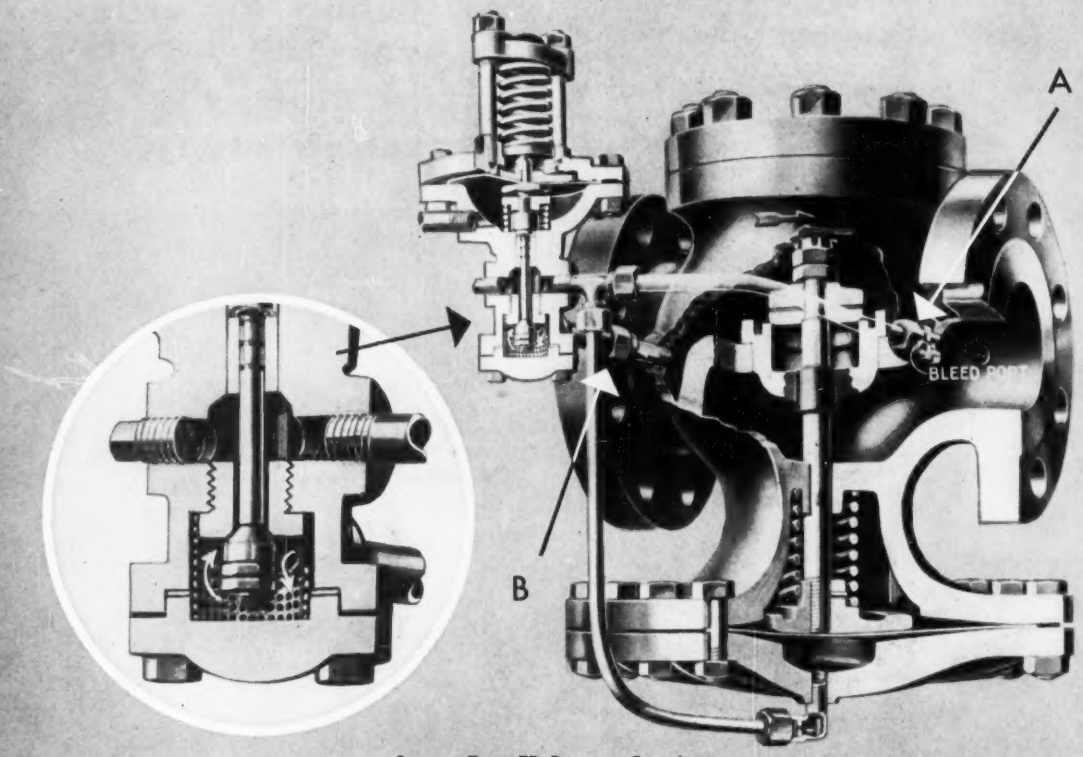
7801

Diamond

DIAMOND POWER SPECIALTY CORP.

VALVE TIPS:

Advantages of External Pilots in Automatic Regulating Valves



Spence Type ED Pressure Regulator

"Maintenance-free, trouble-free, install-and-forget." They're all pretty phrases, but every engineer knows from experience they don't apply to regulating valves. Any valve designed to control temperatures or pressures within tight limits can be affected by dirt or other foreign matter in steam lines.

One advantage of the external pilot mounting shown above is simplified maintenance. Trouble shooting is faster, downtime is reduced, and tempers don't take such a beating. Here's why:

If trouble develops, it's easy to find out if it's in the pilot or the main valve. Just remove the tubing bend at A. A simple test, without any instruments or other equipment, shows where the trouble is.

If the trouble is in the pilot, you can remove it by disconnecting the unions at B. There's no need to take the main valve out of the line.

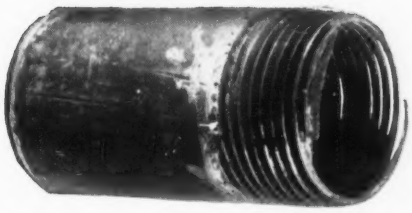
The quickest way to get the regulator functioning again is to install a spare pilot. This is easy — and in the Spence design it's not expensive to carry spare pilots. Spence pilots fit all sizes of Spence main valves. There's no need to stock an expensive inventory of pilots for each main valve size.

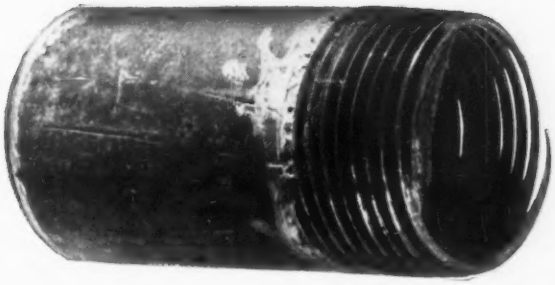
In the enlarged sectional drawing above, you can see how the strainer, seat and disc of the pilot are readily accessible by removing the blind flange.

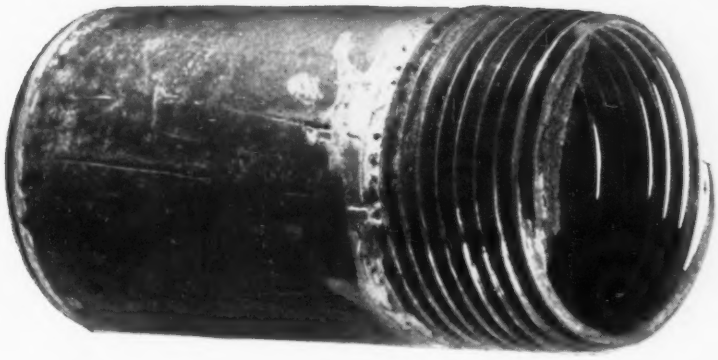
If the trouble is in the main valve, here again inspection is easy. If there's dirt in the steam line, it may clog the bleed port or restriction orifices. In the Spence design these can be inspected and cleaned by merely removing the tubing connections. The seat and disc of the main valve can also be inspected easily by removing the top flange.

These maintenance advantages, plus other advanced design features, are available for a wide range of regulating applications. For information on Spence's wide range of different automatic regulating valves, write for your copy of Bulletin 1005.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York







● *Unretouched photos showing carbonic acid destruction typical of untreated pipelines.*

EASY TO SEE THROUGH – AFTER IT HAPPENS

It's too late for water treatment after the damage is done. Replacement of these threadbare nipples in the return line was only a matter of time. The grooving-type corrosive action of carbonic acid took care of that.

Destruction like this can be stopped with Dearborn Alkameen,* an amine in liquid form which dissolves in the condensate to neutralize the corrosive action of carbonic acid.

A Consulting Service for You. Whatever your problems—raw water supply...power plant data...cooling towers, ponds...types of fuel...equipment...test and control methods—Dearborn has the engineers, the experience and the facilities to assist you in developing the program exactly suited to your needs. Your Dearborn representative will outline the many advantages a Dearborn Consulting Service Program will give to you.

**Alkameen is a trade-marked product of Dearborn Chemical Company.*

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Merchandise Mart Plaza, Chicago 54, Ill.

☐ Have a Dearborn Representative call
☐ Send your new booklet on Dearborn Consulting Service

Name.....
Title.....
Company.....
Address.....
City.....*Zone*.....*State*.....

Dearborn®

...the leader in water conditioning and corrosion control since 1887

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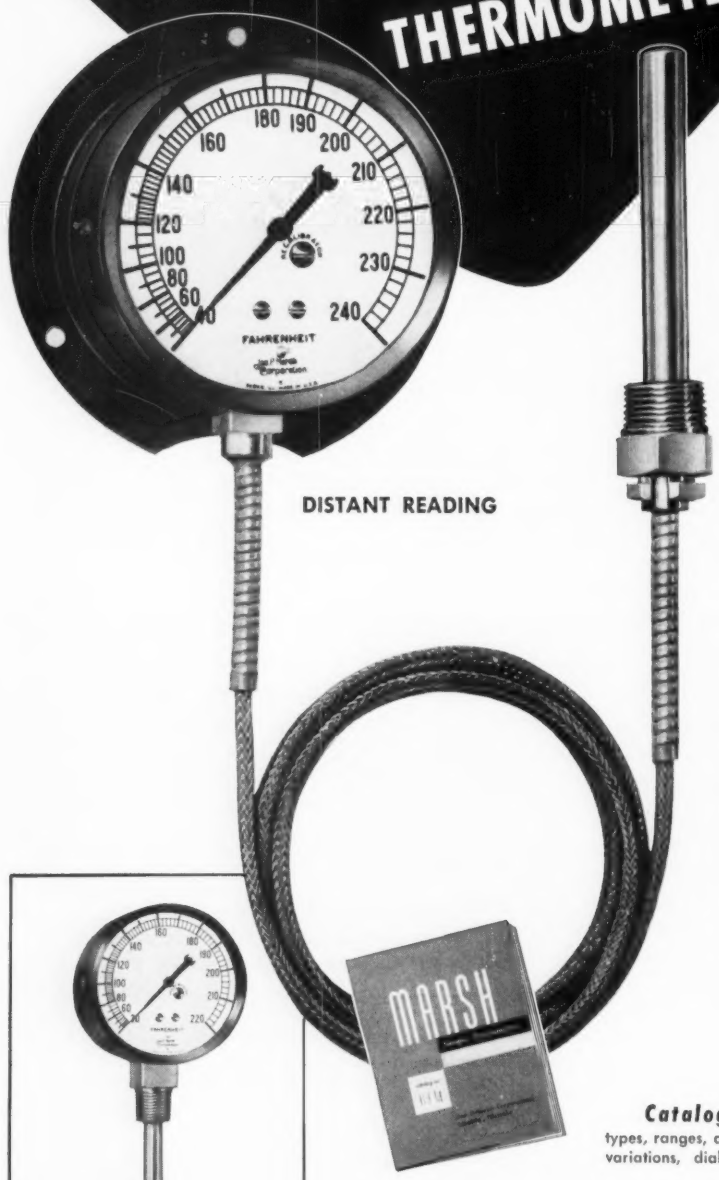
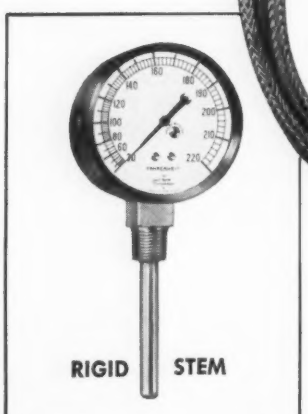
MARSH

Vapor Tension DIAL THERMOMETERS



DISTANT READING



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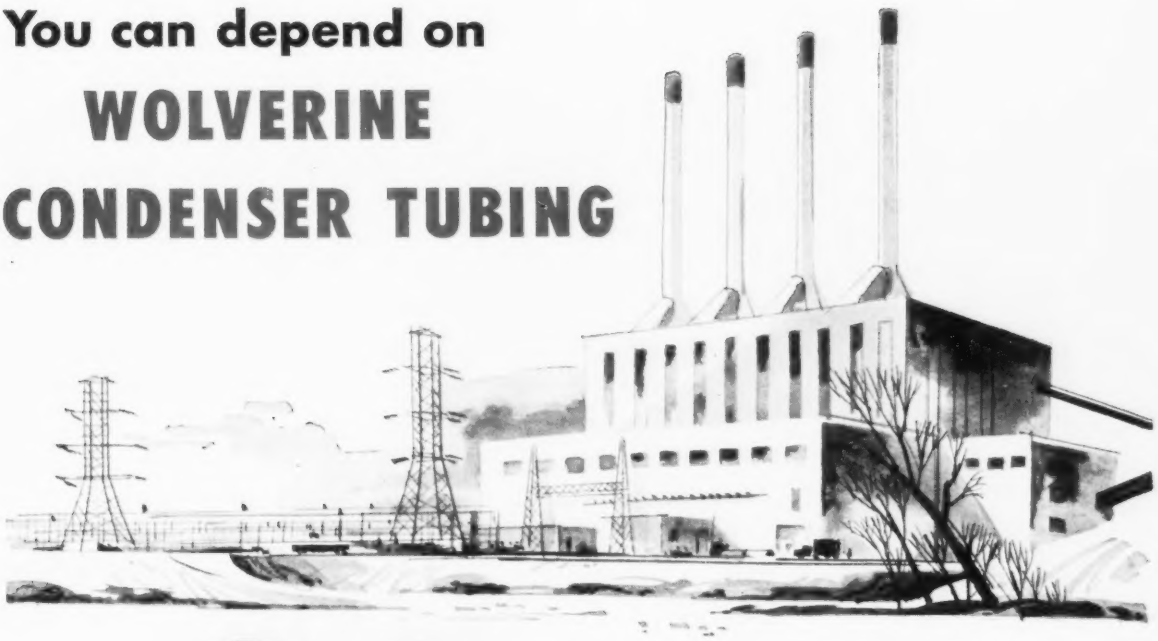

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For condenser tubing you can depend on, specify Wolverine Tube. If you have a problem in design, corrosion or tube selection—bring it to Wolverine's Field Engineering Service. For complete information about Wolverine products and services write for your copy of the Condenser Tube Catalog.

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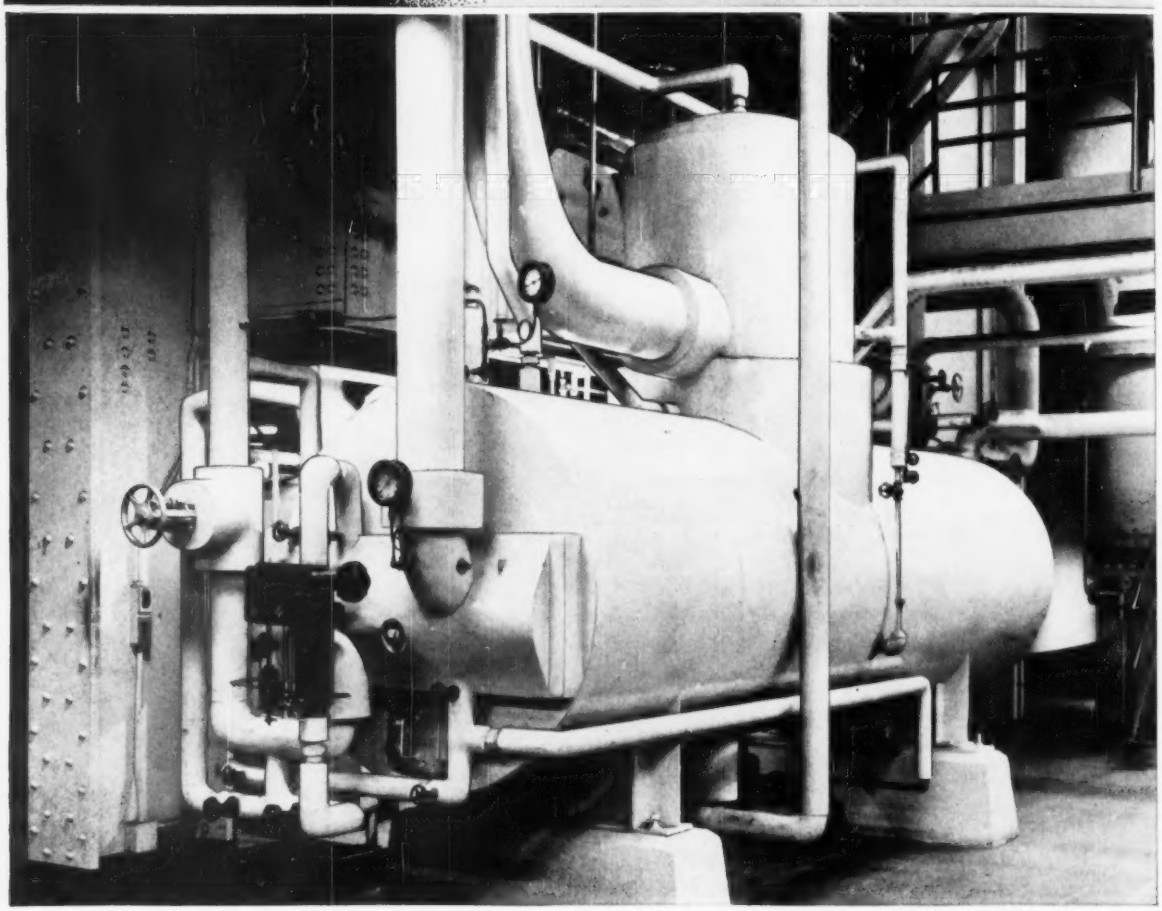

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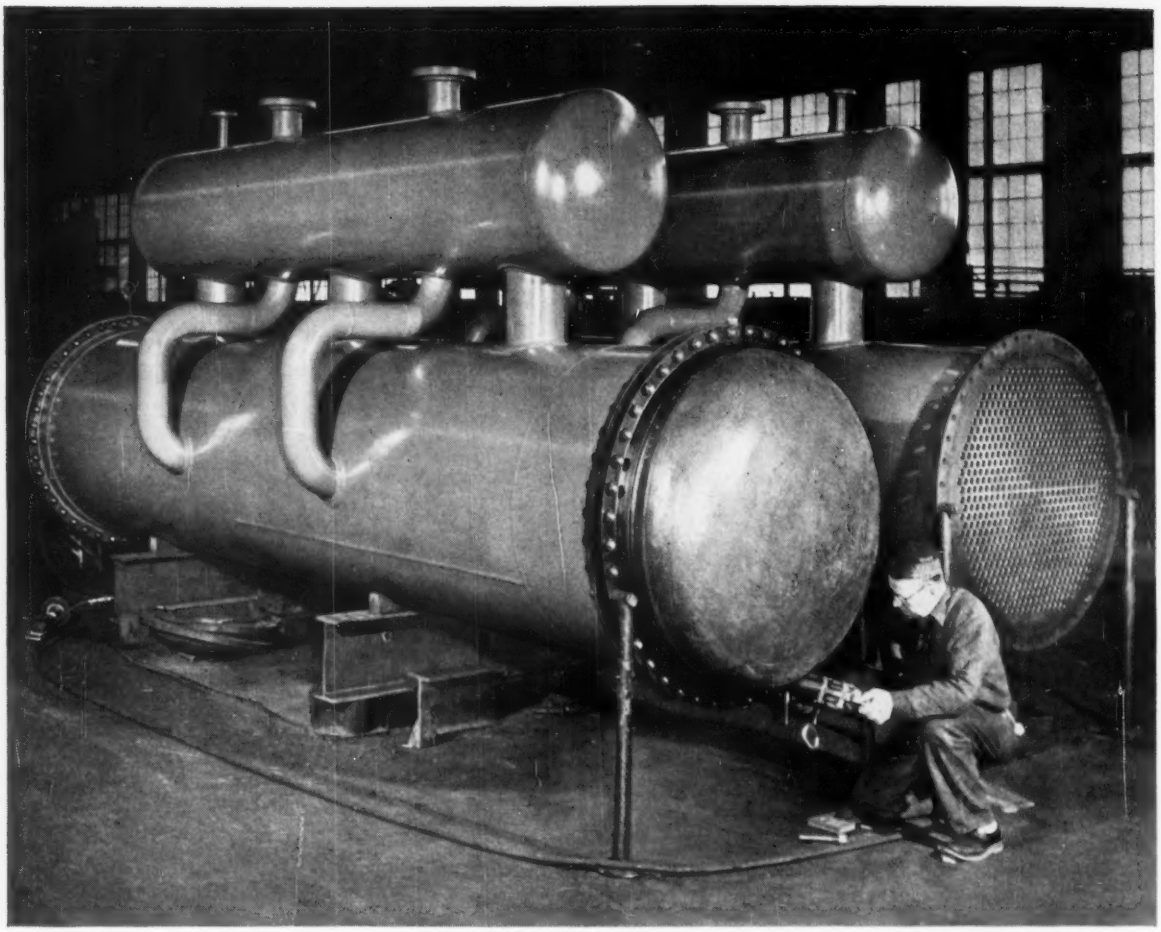

Single source supply—B&W tubes, fittings and flanges expedite production of this ethylene glycol chiller.

One Call Will Do It All . . . Specify Tubular Products From B&W

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LOUIS N ROWLEY, EDITOR • JANUARY 1958 • ESTABLISHED 1882 Power

New year, new challenges

YOU'LL find new values in this first issue of POWER's 76th year—advances designed to make your magazine even more useful and readable.

Time after time you have told us—through our regular reader surveys and through informal comments—that POWER's usefulness is vastly increased by our unique special reports. Ever since 1935, each year has brought you four or five of these condensed "handbooks," each presenting an up-to-the-minute picture of some important segment of the power-service field.

Now, *every* issue will carry a staff-written report. As in the past, four or five of these will be of the familiar 16- to 48-page "handbook" type. To these will be added the all-new "Today's Development" reports—designed to help you keep up with the ever quickening pace of progress.

Like the first "TD" report on electronic computers, pp 71-77, each of these new features will explore a part of the power-service field where technical advances are coming fast. Each will round up and evaluate ideas and developments that promise to influence tomorrow's practice.

As engineers, we know you put prime emphasis on the "goods" we deliver in our pages—the regular menu of carefully selected articles and practical departments, plus the "handbook" special sections and now the new "TD" reports. But everyone likes to see a good product well packaged. So we've been making a critical re-examination of each element in POWER's format—the package.

This month you see some of the results. A new, more-open table of contents, p 3, helps you find wanted information faster. Advanced page layouts organize ideas so they may be grasped quickly. With streamlined writing to pack more facts into fewer words, we were able to redesign POWER's typography and enlarge the text type for easier reading. This all adds up to another step forward in our sustained effort to move ideas from printed page to reader's mind, fast and clearly.

In future months, you'll see further advances: new departments and improvements in familiar ones, plus a significant special issue in October. These are parts of a continuous program to maintain and enlarge the vital forward-looking editorial service to which we repledged ourselves as we passed the 75-year milestone in POWER's leadership. Never has there been greater need for such an editorial service because never have the challenges to our engineering skills and ingenuity been tougher. It is our New Year's wish that all of us may rise to these opportunities for achievement.

C-E BOILER

"Makes a hit"

AT NEW GLATFELTER PLANT

Consulting Engineer tells why...

After completion of Acceptance and Peak Load Tests on a C-E Vertical-Unit Boiler, Type VU-40, at the P. H. Glatfelter Company's new Spring Grove, Pennsylvania, paper mill, The H. M. Wilson Company, Consulting Engineers of Philadelphia, stated, "Now, having determined the results of the tests, we are happy to advise you that the overall performance of the boiler was excellent, and we feel that this particular boiler is of outstanding design and construction. We have previously commented on the excellent cooperation of your Engineering Department in the design and development of this boiler, and can only reach the conclusion that your entire organization has been most cooperative and has done a fine job."

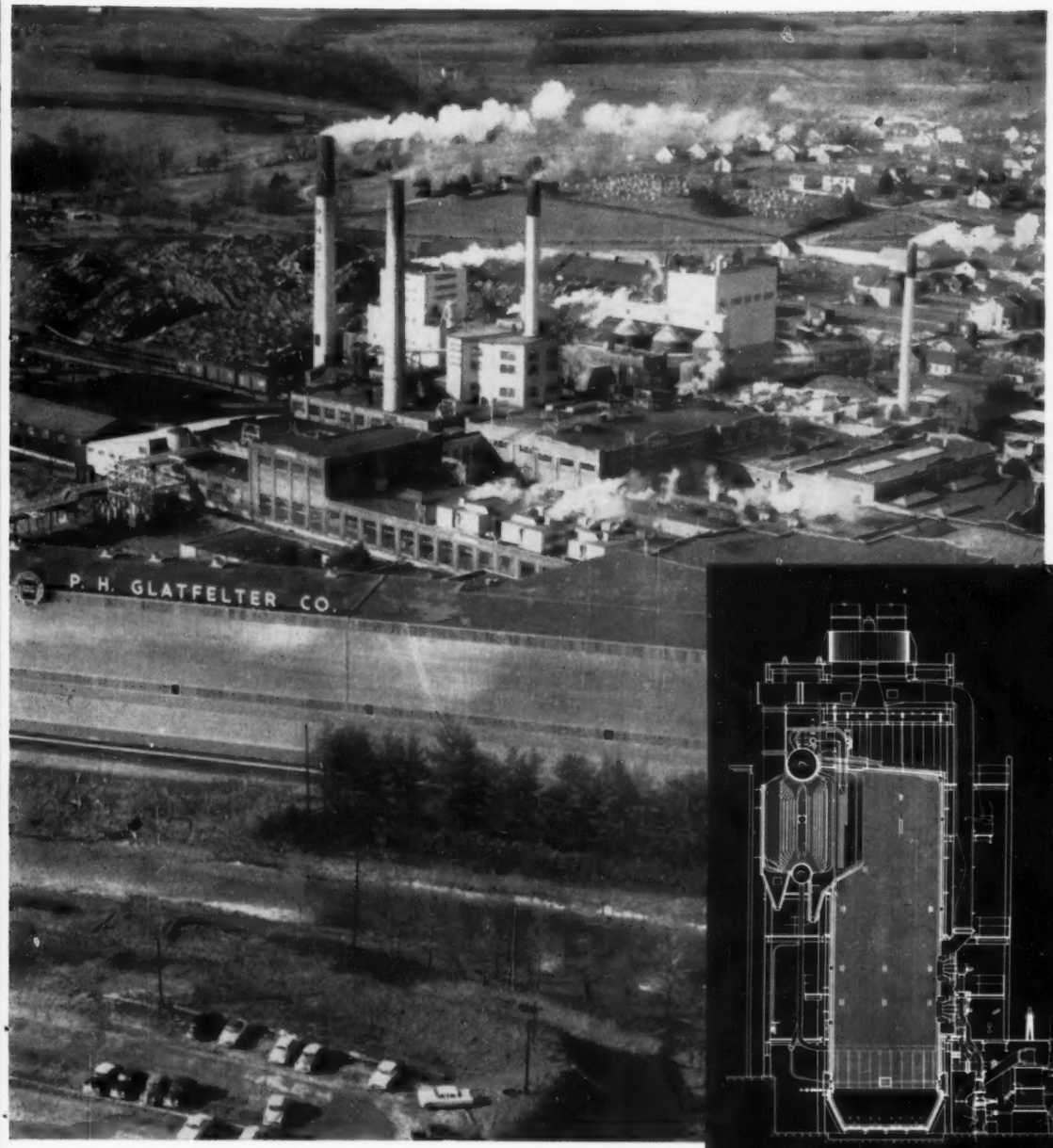
This opinion finds added significance in a statement by the company president, Mr. P. H. Glatfelter, III, who states, "We are well pleased with our choice of this C-E boiler for our new plant."

We, of course, are proud of this boiler, which, like the many other C-E installations of this and other types, is proving its superiority under actual operating conditions. When *you* need boilers, remember that Combustion Engineering has a complete line of steam generating and fuel burning equipment—a size and type that will meet your requirements exactly.

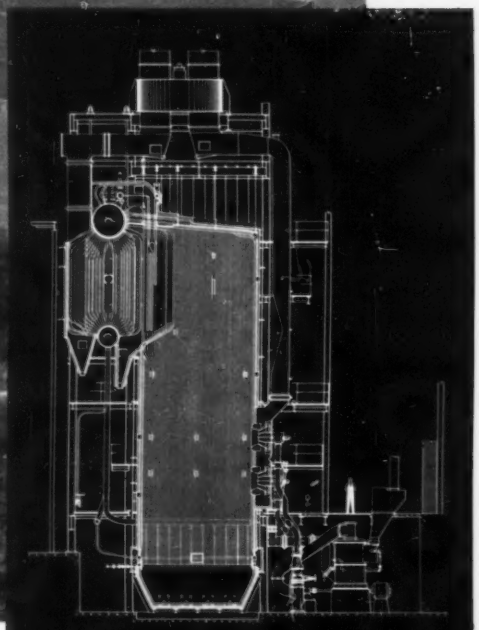
COMBUSTION

Combustion Engineering Building

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS



The recent start-up of this new paper mill marked the completion of the P. H. Glatfelter Company's largest expansion in its 93-year history. Included in this expansion was a new Fourdrinier paper machine, a 177-acre lake, and a C-E Vertical Unit Boiler. This new mill, which is in the best tradition of modern industrial architecture, has a potential capacity of over 300-tons daily.



Cross-sectional view of the C-E Vertical-Unit Boiler, Type VU-40S, installed at the Glatfelter Paper Mill in Spring Grove, Pa. This unit is designed to burn coal or oil, either separately or in combination, with full rated capacity obtainable from either fuel. It has a maximum continuous capacity of 250,000 pounds of steam per hour at 600 psi and 650°F.

ENGINEERING

C-138

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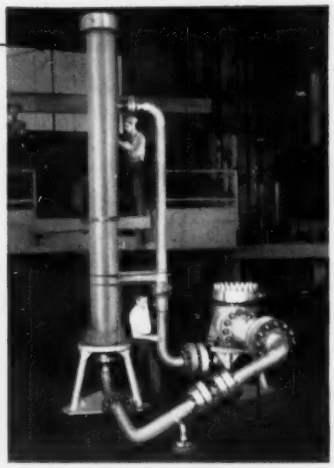
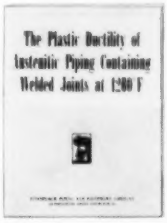
ALL IN A DAY'S WORK at *Pittsburgh Piping*



STAINLESS STEEL AUTOCLAVE and VOLUTE
Shop Fabricated

by *Pittsburgh Piping*

This autoclave and volute assembly is typical of the work that goes through Pittsburgh Piping shops. Fabricated of Type 304 Stainless Steel, it is complex in design and is built for high pressure, high temperature service. This type of fabricating is a "natural" for Pittsburgh Piping. We pioneered the application of austenitic steel piping materials for central stations operating at 1050°F. and above, and fabricated the piping for the world's first atomic-powered submarine and central station. Highly specialized methods, machines, and apparatus have been developed and are employed in this work. Use them on your high temperature, high pressure piping jobs.



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This bulletin reports an intensive investigation into the problem of main steam piping materials and gives data on the stress rupture characteristics of Types 316 and 347 stainless steel piping adjacent to welded joints.

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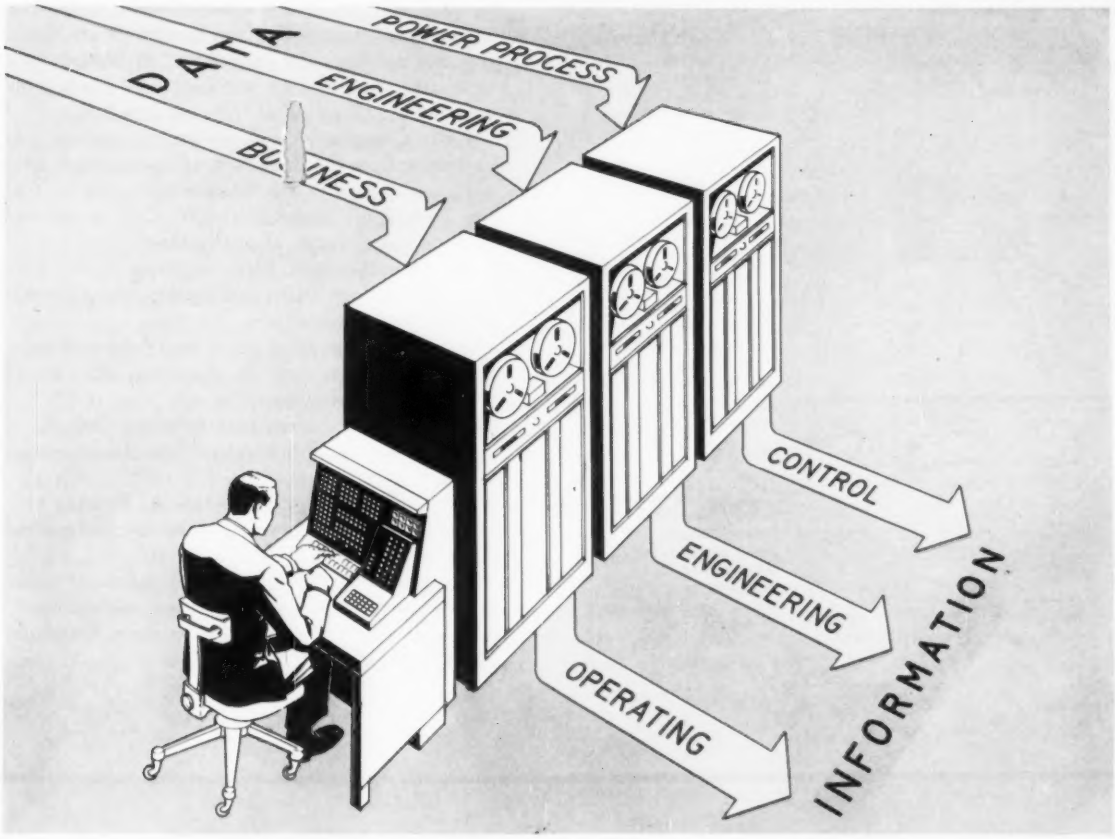
Design and equipment application section

B G A SKROTZKI
Associate Editor in Charge

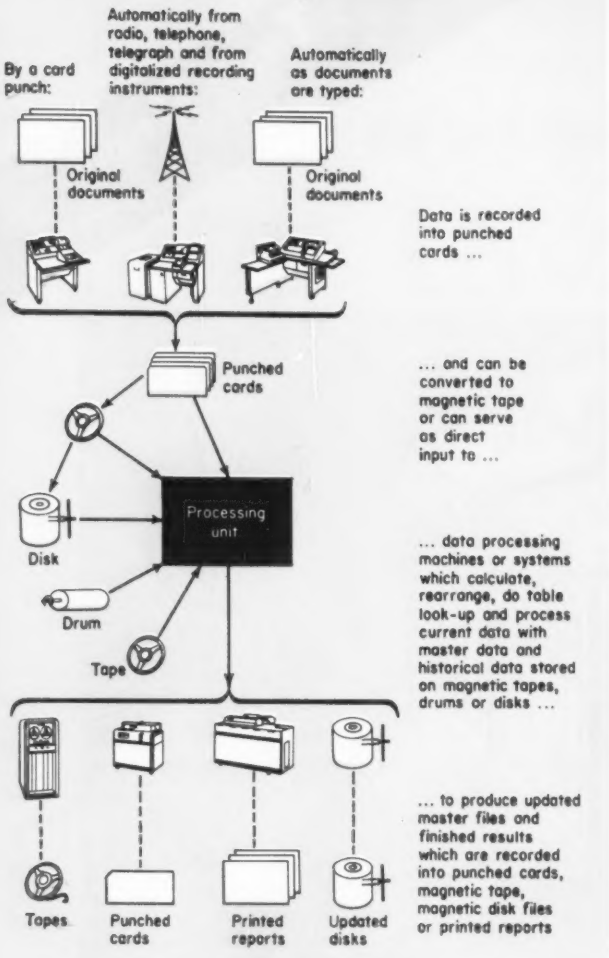
a Today's Development report



Electronic computers: Their power-field future looks bright

By HOWARD P KALLEN, Special Projects Editor

Electronic data-processing machines (EDP), both large and small, are beginning to move into the power services in a big way. They are handling complex engineering, business problems right now. Soon they may be stepping into your automatic control systems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Automatically from radio, telephone, telegraph and from digitalized recording instruments:
Automatically as documents are typed:
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Original documents
Data is recorded into punched cards ...
Punched cards
... and can be converted to magnetic tape or can serve as direct input to ...
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Disk
Drum
Tape
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Tapes
Punched cards
Printed reports
Updated disks

Basically, the digital

Chances are, if you don't happen to have a computer already operating in your plant, you think of them in the same vein as satellites, missiles, thermonuclear power, etc—something that won't concern you for a long time to come. Maybe so, but take a careful look at how computers are changing engineering and power-service management practices, some of long standing, and you'll probably reverse that kind of thinking in a hurry.

Today's computer hardware varies in complexity and price from the giant "brains" costing well over a million dollars, to the "poor man's" versions that can be had for under $100,000. Each is tailored to a particular range of applications.

Scanning the field, here are some of the more important power-service and management jobs that computers have taken over:

- Precise evaluation of power load flows and transmission losses as well as economic analysis of planned interconnections
- Preparation of plant heat balances, analysis of h-p h-t piping flexibility, calculation of incremental heat rates
- In the nuclear field, computers are figuring neutron-absorption breakdown, gamma-ray attenuation, statistical problems
- Computers are handling a great variety of otherwise lengthy, laborious engineering calculations
- On the business side of the picture, electronic data-processing machines (EDP) now speed inven-

What to consider before you buy or rent a computer

Like any other piece of major equipment, the purchase or lease of a computer requires justification—generally economic. Because of the "glamor" that's likely to be associated with a computer installation, some have been bought for less compelling reasons. But basically, you should go about deciding on a computer installation in much the same way as you would decide on a new boiler. Cost reduction along with improved operations are your most likely reasons for considering a computer.

First, define clearly the objectives of the proposed system. Suppose you're considering it for automatic-system load control. Start by pinning down present costs for the operation. Be sure to take into account the results you're now getting. How close, for instance, does the present method bring you to continuously optimum conditions? How much would it be worth if you could come a specified increment closer to these conditions?

Based on how you plan to use the computer, you'll need to determine the capacities and characteristics of the input and output units, the memories or data-storage devices, the arithmetic and its associated elements. If you don't have a computer expert on your staff it may pay you to call in a consultant for this phase of your study.

Equipment availability is a key factor. Look at the units offered by *all* reputable manufacturers and weigh them against your specific needs. Finally, don't overlook manpower requirements, auxiliary equipment (air conditioning, for example), room needed.

computer is a "super-speed" counting machine

tory paper work, customer billing, payroll accounting and a host of other operations necessary for smart management decisions

Yet the full potential of EDP is only beginning to unfold. Engineering and business problems that once took weeks and months to solve—some of which wouldn't even have been attempted—are now done in a matter of minutes. In fact, one of the snags you may face in trying to justify a computer is finding enough work to keep it busy. But with the greater range of sizes now available, computers are moving into the small-plant market in a big way.

How the computer does its job. The simplified diagram, facing page, shows the possible paths that data can take in being processed by a digital-computer installation. Even the simplest digital computers need at least four basic elements: input-output units, memory or storage equipment, control units and arithmetic elements.

Most memories store numerical data from electrical pulses, deliver read-back in the same form. Large memories generally use magnetic tape, as many as 40 tracks being used across the tape.

Magnetic-drum memories fit where you need rapid access to data as well as large capacity. Magnetic cores are also finding wide use in computers.

Control elements are switches and counters that receive instructions from a programming source and relay commands to all the different parts of an arithmetic element, pacing the element through each of the many required automatic calculations.

Arithmetic part of the computer, consisting of data accumulators and other devices, actually carries out the program. Completed calculation goes from the output element to read-out devices such as punched tapes, cards and electric typewriters.

Having viewed the basic elements of the computing system, let's look at the A-B-C's or, more appropriately, the 1-2-3-'s of a digital computer.

In its simplest form the computer is a counting machine—a highly complex *abacus*. It accepts information in the form of numbers, processes this info by performing the familiar arithmetic operations (in accordance with the program we spoke about earlier) and supplies digital answers. Thus, counting and the operations closely associated with it—addition, subtraction, multiplication and division—are basic to all general-purpose digital computers. And since the computer must store data, its storage facilities set the precision limits on answers.

Today's electronic "brains" can't do your thinking for you. They add nothing *new* to the data input; they simply alter it to a more useful form. In fact, if you err in preparing the machine's program, the output will continue to reflect this mistake until the program is corrected.

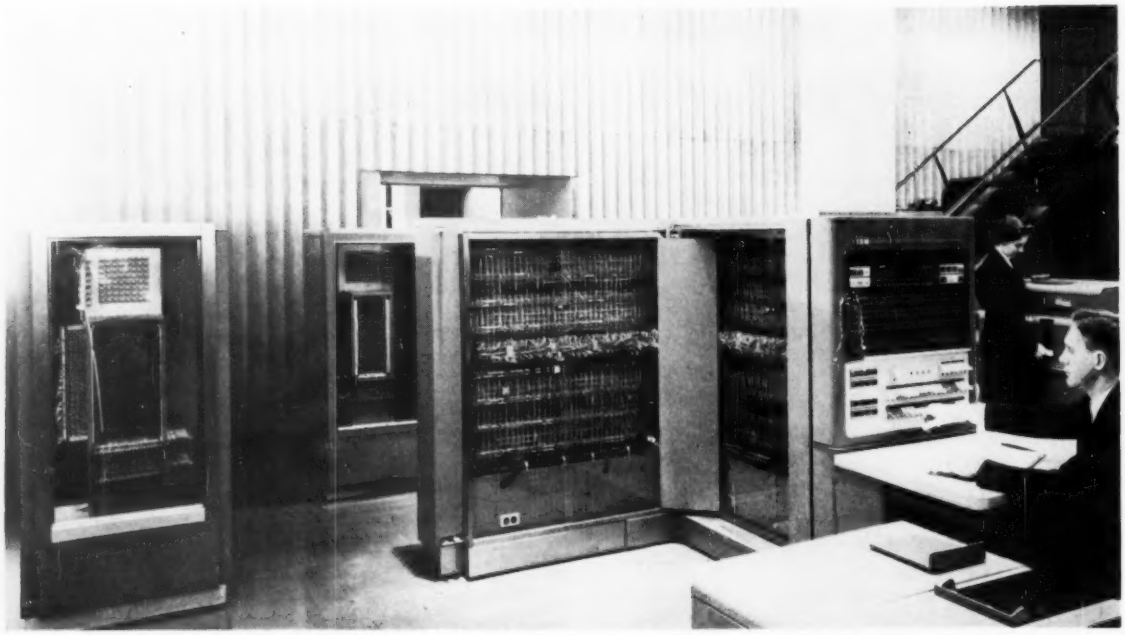
Key feature of the digital computer is its knack for assimilating random numerical data that follows no particular natural law or formula and for

How do digital and analog computers differ?

At the risk of oversimplifying our answer to the above question, we might say that comparing analog with digital computers is like comparing a simple engine lathe with a high-speed automatic screw machine. At present, each has clear-cut applications not touched by the other. Yet, analog units can do much that the digitals can do and *vice versa*.

Main differences between the two are the result of their different approach to mathematical problems. The digital computer, in essence, is a counting machine, performing arithmetic operations on digits. Thus, input and output are digital. And problems fed to it must be stated in numbers. Its analog counterpart, in contrast, operates directly on physical quantities—voltages, pressures, shaft positions, etc. ("Analog" refers to the analogy—voltage, pressure, etc—with the measured physical quantity on which the computer operates.) Thus if the data follow natural physical laws or can be written in equation form, use of the analog machine might well be indicated. If data are completely random, the digital computer is, for practical purposes, a must.

The high-speed digital computer can store and refer to tremendous quantities of data, perform complex computations in fractions of a second. But the programming (like tooling-up) might take several man-months to prepare.



GIANT ELECTRONIC "BRAIN," the IBM 704, is designed mainly for engineering, scientific computations, does its high-powered operations at a rate of 40,000 per sec. The machine's magnetic-core memory stores data that can be used almost instantly

General-purpose digital computers can solve a

How about computer centers?

If you've run a careful cost analysis and find that you just don't have enough work—in both business and engineering problems—to keep a computer going, then services of an outside computer center may be your best bet. That way you split the cost of a computer installation with others.

Many computing centers have sprung up in recent years, sponsored by colleges, computer manufacturers and privately operated groups. Some will even go into your plant, tell you which of your operations can be "computerized."

Most computing centers are geared to study your problem, program it and run the machine for you. Drawing, top of facing page,' shows you needn't be close to the center to use it. Data can be sent by teletype or other convenient means; returned the same way.

Costs of engaging computing-center services vary, depending on the machine your work requires. Giant brains, such as Remington Rand's Univac or IBM's 702-705 machines, rent for several hundred dollars per hour. Smaller units cost correspondingly less.

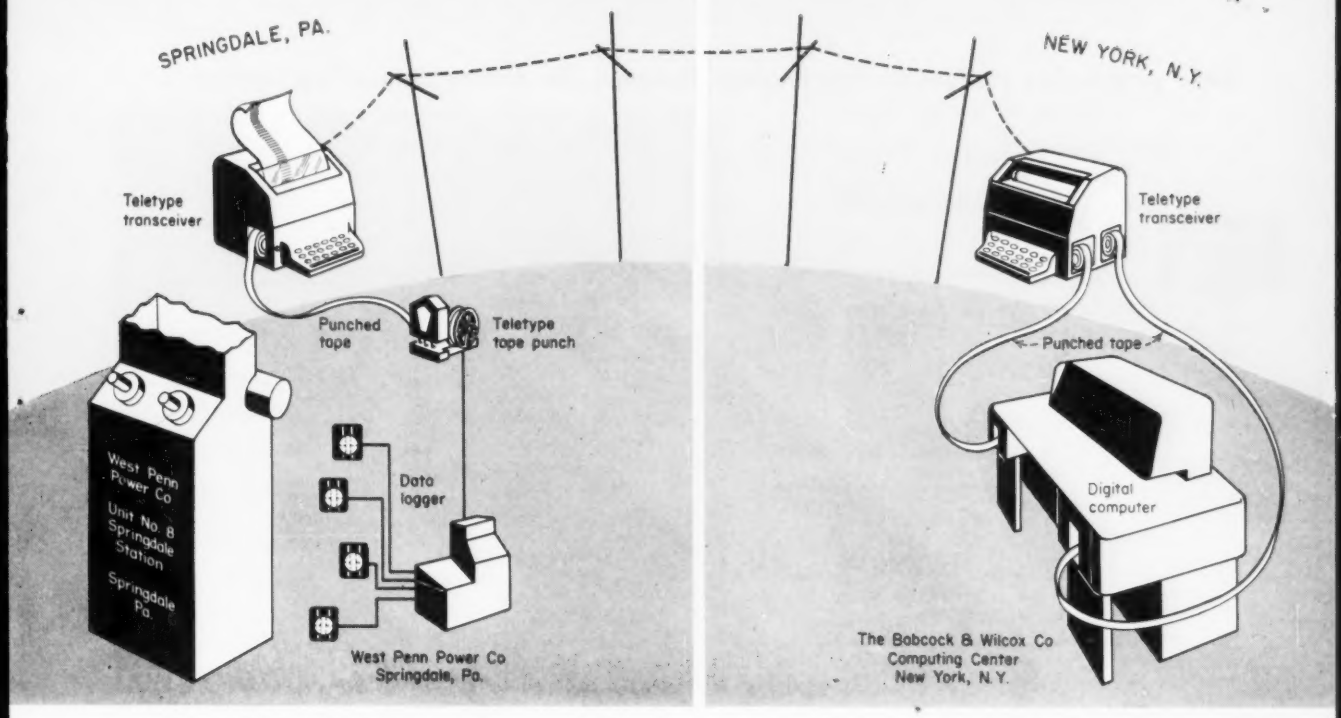
sorting out such info after storing it. This is a highly useful trait in many computer applications.

In brief, the computer stores numbers, acts on them according to a digital program, and furnishes answers in digital form.

Computer applications. In two of the three areas shown in drawing, p 71, computers are already firmly established—processing business data and solving engineering and scientific problems. The third, digital-computing control, is still in its infancy but holds much promise.

Main functions of the business-data-processing class of systems are: (1) To perform routine record keeping (inventories, customer billing, etc) based on programmed procedures. (2) As a result of record keeping, to come up with various statistics (medians, means, extremes, etc) that are measures of operating efficiency. (3) To make computations that serve as a basis for management decisions. For example, computer might compare costs with a predetermined standard, print out code numbers for operations on which costs are above standard.

Common difference between business-data processing and other types of computers is the large data file or storage usually needed for business problems. The programs for them are generally long but relatively simple. Thus, business operations that can best be handled by EDP have large volumes of information for input, require consid-



NOVEL BOILER TESTING setup takes automatically scanned and logged data from unit in Springdale, Pa., transmits it over teletype to B&W center in New York. Computer is a magnetic drum design (Datatron) that figures boiler efficiency, other data

wide variety of your engineering, business problems . . .

erable editing of this info and have an essentially set schedule of operations to meet repeated, periodic demands.

In contrast, computers for the solution of engineering and scientific problems generally handle conditions that haven't been solved before—at least on the scale assigned to the computer. Often, they are nonrepetitive and of great variety. In the power and plant-services fields alone, problems might range from short-circuit calculations to turbine-generator performance. Thus, engineering computers generally must come closer to being general-purpose machines than either business-data processors or computing controllers.

Compared to the amount of actual computing, data processing and transfer in the solution of engineering problems is relatively minor. And even the most complex of such problems don't approach the extent of input and output data you're likely to encounter in business operations.

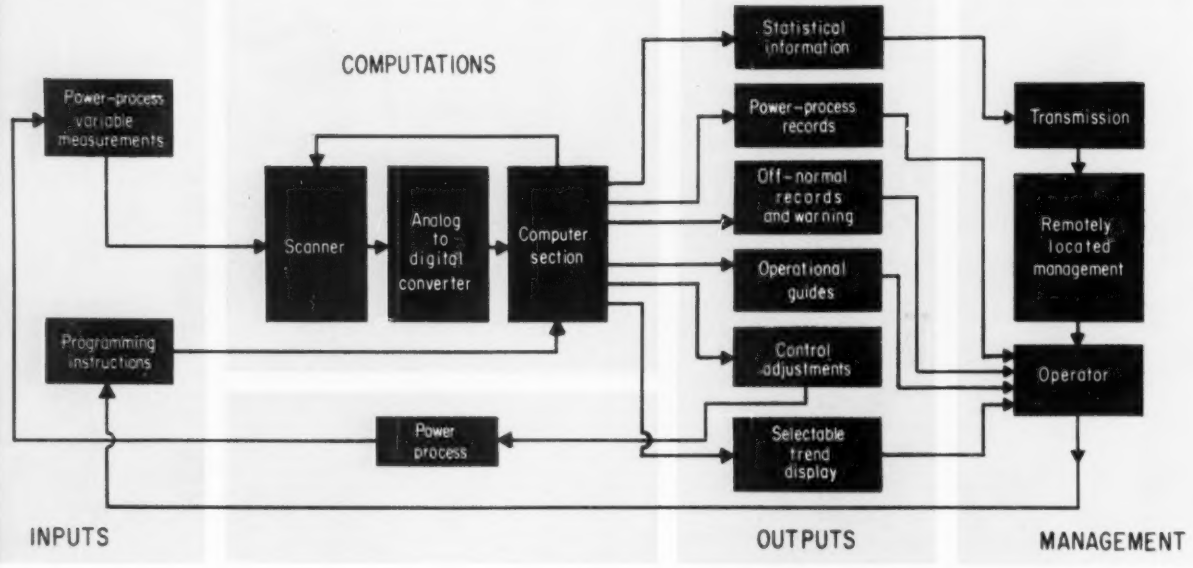
An unusual application of digital-computer and automatic-data handling is the boiler-testing arrangement, drawing above. Result of a joint program of Babcock & Wilcox and Bailey Meter, its aim is to reduce manpower and time required for field-test work on boilers.

Test points (pressures, temperatures, flows, gas samples) are scanned and logged on a coded paper tape. Points are selected to allow automatic computation of boiler efficiency, heat absorbed in each part of the convection pass, the gas temperature entering and leaving each section of the convection pass and overall conductance of each major section.

Data output, in tape form, is teletyped to a remotely located computing center (the B&W computing center in New York), fed into the computer. Results are transmitted back to Springdale where these tests are run. Finished info can be back at the station in less than an hour from the start of test. Speed of data collecting and computing allows the engineers to take "snapshots" of the unit rather

MEDIUM SIZED COMPUTER operates on full schedule for Union Carbide & Carbon at its New York headquarters

Data processing system at Sterlington designed for future computing control



. . . and, in closed-loop control systems, they may soon

than "time exposures" or time averages over an hour or more. The approach is basically a new concept in steam-electric generator testing.

Computing controls. Probably the most exciting new area for digital computing techniques is that of automatic control. As a practical industrial technique it's only in embryo stages. In fact power men are far from unanimous on its place in the power services. But, from a long-range viewpoint, computing control *could* have far-reaching implications. It *could* revolutionize present-day power-control thinking.

Computers used for automatic digital control are often called "real-time" control-data processors, because, in contrast with business and scientific problem-solving machines, they operate in a closed loop whose time constant is a critical factor in performance.

Why computing control? Proponents of the technique see its main justification as improved performance. And as plants get larger, smaller percentage gains in efficiency can justify greater investment in equipment. This thinking, of course, applies to the performance gains that might be made as a result of computing controls.

We've seen that control engineers expect better performance from digital-control techniques. Theoretically at least, their accuracy is virtually limitless. This is true of even the relatively small electronic computers. Thus the system designer should be able to specify conditions accurately, limited only by economics of the situation.

Another point favoring computers for control is their flexibility. Simply by changing coded information (the program) the computer can be given a new control function. To some extent, today's interchangeable modular-control packages offer this feature. But their limits are, of course, narrower than those of a computer.

The conversion problem. To take advantage of digital control the engineer must have an effective way for the computer to communicate with the rest of the system. Inherently, control systems start by *measuring* natural physical quantities, do their job by continuously *adjusting* physical units. Between these points a computer which deals in numbers (a man-made convenience) comes in. Thus the need for a practical analog-to-digital conversion device. A number of good ones are now available commercially. Photo, facing page, shows one with digital read out.

Physical parameters we are likely to measure are generally delivered to the converter as a voltage or as a shaft's rotational position. The converter, playing much the same part as a person reading an instrument, expresses these results of measurement as numbers. Two additional methods, time-to-digital and frequency-to-digital conversion, hold considerable promise.

Digital control could conceivably get its biggest

provide computing control

push from the advent of unique new instrumentation designed for greater compatability with digital systems. Also important will be greater emphasis on special-purpose computers—units designed for a particular range of control problems. These will not only aid the systems designer, but bring economic justification for digital methods within shooting range.

Closest the power services have yet come to computing control is the system shown on the facing page. Designed by Daystrom, Inc for the Sterlington Station of Louisiana Power and Light Co, the equipment will include a transistorized digital computer. Actually, while the system is designed for full computing control, it will start operation as an automatic information-gathering (data-logging) system, with computing-control features planned for later addition.

Summing up, costs will be a prime factor in gaging how fast computing controls will hit the power services. More than one controls expert is betting that, even when they come, they won't act as the primary control means. Instead, they'll provide a means of "vernier" control, continuously adjusting set points to get most efficient operation. In the language of the controls engineer—optimizing control. But, plainly, computing controls are and will continue to be an area of development that bears close watching and continued evaluation by forward-looking power-service engineers.

How soon and how hard will computing control hit the power services?

There are few controls experts who doubt that computing controls have an "eventual" place in the power services. But even fewer will flatly tell you when, how much, and what specific areas. Yet if we take a close look at recent trends and what's projected for the immediate future, piecing a likely picture together is not too difficult.

- Clearly, plants are becoming larger, more complex. Single turbine-generator units up to 500 mw are on the boards. Even larger machines are in sight. This continuing trend led us, years ago, to the development of centralized control systems. And while the central system is not part of computing-controls technology, it *is* an important prerequisite as far as the power field is concerned.
- We've seen a number of incremental load-control systems bow in that make use of both analog and digital techniques (Ohio Edison's GEDA; Southern Co's "Early Bird," Bonneville Power's digital computer).

Several automatic digital data-gathering systems are now in service, both in the U.S. and in Canada (POWER, April 1957, pp 73-79). One plant (Neches Station of Gulf States Utilities) not only gathers data but automatically figures efficiencies on a special-purpose computer.

Soon to go into operation is a digital data-processing system at the Sterlington Station of Louisiana Power & Light. This system is designed so that computing control can be added at a later date without redesigning the system, diagram, facing page.

- Thus, it's a good bet that the digital loop will eventually close. But most power engineers are feeling their way cautiously. For one thing, they'd like to see how reliable automatic digital data-collecting systems will be over the long pull.
- Also, lacking precedent, there's little info on which to base economic-justification studies. And, probably most important, many potential users aren't fully aware of advantages and limitations of computing control. Hence, a strong educational job needs to be done. Needless to say, applying computing controls incorrectly will do more harm to their cause than not using them at all.
- In brief, we can expect to see a slow start for computing controls in the power field. There'll be more automatic data-logging installations that will provide an experience base for digital techniques. It will undoubtedly be the early 1960's before the philosophy begins to take hold. But, if early experiences are as good as their present promise, the growth curve could soar rapidly.

Metalworking company heats an all-steel building with 26 infrared generators

Infrared heating can be practical

What are infrared rays?

Infrared rays are waves of energy produced by the sun, a fire or heated object. They are a member of the electromagnetic-wave family. Wave length is longer than that of light and shorter than radio waves. All these waves (1) travel in straight lines at 186,000 mps (2) do not affect bodies that they pass through, only those which absorb them and (3) can be reflected with mirrors or focused with lenses.

Infrared may be classified into "far" and "near" rays. "Near" infrared comes from that part of the spectrum nearest light. It can be produced by infrared electric-light bulbs. But this is an inefficient heat source since much of the energy is dissipated as light. "Far" infrared is produced at lower temperatures and is used for the infrared heating systems described.

Need for heating high-bay buildings such as foundries, warehouses and aircraft hangers is on the increase. Commonly accepted space-heating systems operate indirectly with gas, water, air, steam and electricity. They create a blanket of warm air to reduce body-heat losses rather than heating person directly. In most enclosed areas this is no problem, but as floor space grows and roofs become higher, more and more Btu's are needed to heat greater amounts of air for comfortable working conditions. So heating costs increase proportionately. At loading docks and other partially exposed areas, space heating is almost impossible.

Radiant heating has promise of solving this industrial high-bay heating problem. It has the advantage of heating surfaces and people directly rather than by convection from warm air. Two most common are panel and infrared heating systems. Panel heating uses floor or wall as a radiator by imbedding the heat

Monthly winter heating cost averages about $167 for this 754,000-Btu system

and economical

By C H FOULDS, Vice-President
Perfection Industries, Div of Hupp Corp

source in it. Acceptance has been widespread in home building and similar areas, but cost of installing tubing in floor or walls is a drawback for industrial heating use.

Infrared heat source is mounted above the floor and doesn't need tubing inside walls or floor. But to capitalize on this advantage the infrared generator must be simple and efficient. Main difficulty has been that comparatively low generator operating temperatures don't produce infrared of sufficient intensity. And if a standard gas burner is used to heat metal strips, tubes or louvers which in turn emit infrared energy, overall efficiency is further reduced.

Surface combustion in gas infrared generators is a radically new approach pioneered by the German scientist Guenther Schwank. His design differs from earlier infrared generators because the structure which supports combustion is also the infrared emitter. Metal strips or louvers in an intermediate stage are not needed. So higher operating temperatures are possible with a greater proportion of the Btu input converted into usable infrared.

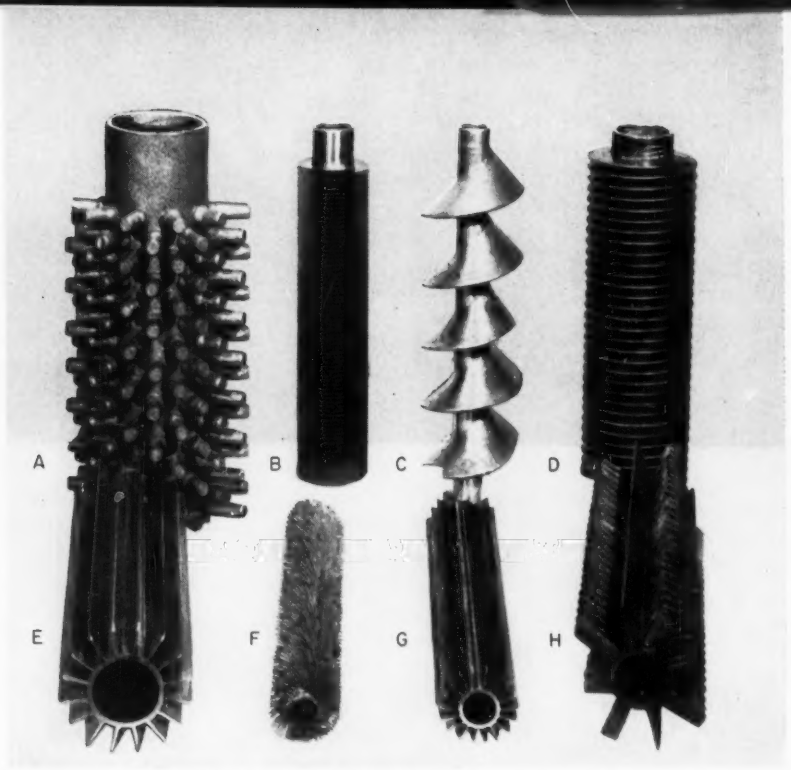
Gas combustion in this generator takes place on the surface of ceramic mats at an operating temperature of 1650 F. Mixture of gas and air is fed through perforations (200 holes per sq in.) in mats. Gas is converted into infrared energy in wave lengths readily absorbed by most common materials. Result is a more economical and efficient generator. Looking ahead, infrared heating of this type may well become tomorrow's conventional method of industrial heating.

Heating cost. Usual calculations for building comfort heating don't apply to infrared. Its rays, like the sun's, warm only bodies which absorb them and not the air through which they travel. Once the energy waves emitted by the gas generator strike a person in their path (or the wall, floor or machinery) they are transformed into heat.

INFRARED generators like this are used in industrial heating system shown above

The same sensation of warmth created by infrared is felt when stepping from the shade into sunlight on a cool day. The body is warmed instantly while the air remains cool.

In an infrared-heated building a person is warmed by radiation from the generator, and also by radiation, convection (*Continued on page* 214)



1 Extended-surface tubing has been developed in many forms to meet the challenge of a wide range of needs for more economical and compact heat-transfer surface

Part 1 of 2-part article lays groundwork for choosing fabricated materials for steam generators heated by gas-cooled reactors. Experience with waste-gas heated boilers in industrial applications makes a good starting point for finding out just . . .

How tubes compare

By PHILIP S OTTEN,
The Griscom-Russell Company

Before we can build a steam generator for a gas-cooled nuclear reactor we must study the conditions under which it will work. Designing a steam generator depends on blending data on known thermal behavior and fluid flow. Before starting to calculate we must decide: (1) materials of construction to be used (2) safety and structural integrity needed (3) location and maintenance needs in plant (4) effect of operating costs (5) choice of heat-transfer surface (6) unit arrangement.

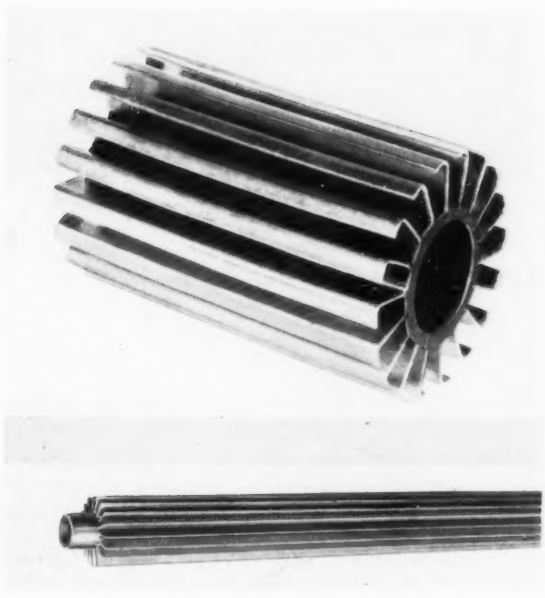
We should build the most economic steam generator compatible with adequate safety. While few gas-cooled reactor plants have been run, gas-heated steam generators have long been used to cool refinery gases and vapors. This latter experience aids in choosing and analyzing the designs we'll talk about here.

Construction materials. Primary coolant gases usually used in reactors do not corrode most metals, even at fairly high temperatures. Noble gases, such as helium, seem to be completely noncorrosive at all practical temperatures and pressures. Some gases, however, become active at high temperatures. For example, at above 840 F and high pressures, hydrogen gradually combines with carbon in steel to form methane, making steel unsatisfactory as a container. Above 1020 F this process accelerates rapidly.

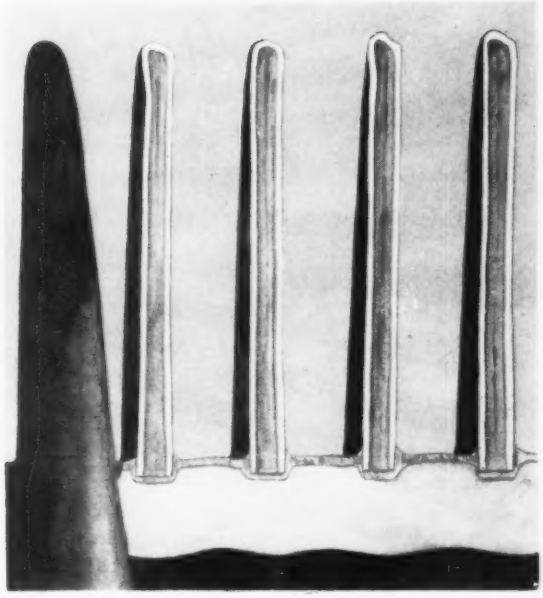
Nitrogen nitrides and embrittles steel and alloy steels above 1000 F.

Steam and water at high temperatures can seriously corrode metals unless carefully treated to reduce oxygen content. Chloride and oxygen must be kept at an absolute minimum to prevent chloride stress corrosion of austenitic stainless materials. Choosing materials in contact with steam and water should follow standard boiler practice. Proper design usually allows using carbon steel or a low-alloy ferritic steel such as 2¼% chromium—1% molybdenum.

Austenitic stainless, such as type



2 Longitudinally finned tubing with curled-over fin, *above*, allows more surface to be packed in a limited gas shell volume



3 Stainless-clad copper fins are helically wound on this tubing and mechanically locked in, supported by additional seal braze

for nuclear reactor boilers

316 and Inconel, have excellent elevated creep properties for parts exposed to gas only. They can be used in final-stage superheating up to 900 F.

Designs we'll talk about will be based on using carbon steel for metals below 800 F, and 2¼% chromium — 1% molybdenum for temperatures up to 1100 F. Austenitic stainless steel or Inconel will be considered between 1000 and 1500 F. At present, insufficient creep data, *ASME Code* stress limitations, and economic factors prevent considering other materials at high temperatures, except for military uses.

Since most primary-coolant gases are not highly radioactive and the steam generator is not exposed to high neutron fluxes these materials should be suitable. For higher radiation conditions the materials must first be tested for their integrity.

Safety. Any boiler design can be made to conform to construction codes and will run at temporarily extreme conditions without gross failure. But we must evaluate the special hazards from small temporary leaks when working with a nuclear reactor.

Small leaks from primary-coolant gas to the steam will not be especially dangerous because of the low mass per unit volume and the low order of radioactivity, if any. Steam leaking to gas, however, might change moderation of the reactor and its reactivity.

For dangerous leaks the designs can use monitored duplex tubing. An inert gas barrier in this tubing seems more advantageous than going to a liquid-metal system. Almost any design can use a monitored duplex-tube system, but U-tubes or sharply bent tubes cannot easily accommodate an inert-gas monitor. Double-barrier systems should be used, preferably with straight tube, bowed tube or bayonet designs.

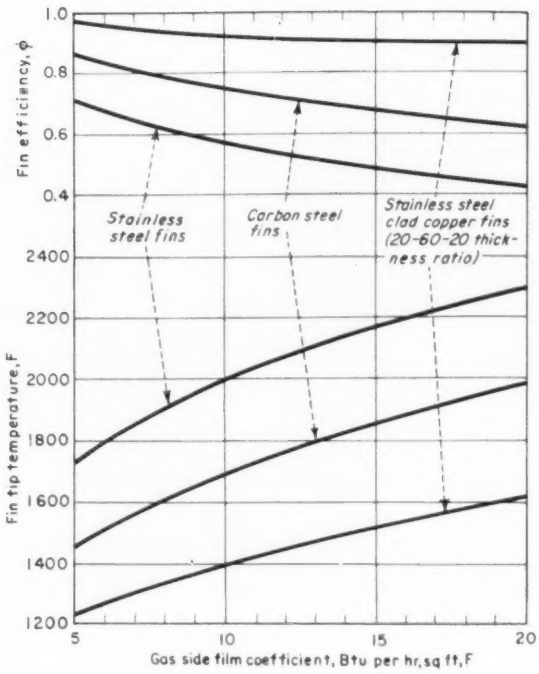
The designs we'll talk about in Part 2 all use single-wall barriers. All the U-tube designs can be modified to straight-tube floating-head types for double-barrier design. Comments on the straight-tube designs also apply to the U-tube units.

We must make special efforts to avoid local conditions that have caused failures in steam generators. Most of these failures occur in the tube —tube sheet joint, the tube sheet and where severe temperature differences combine with structural discontinuities in the regions next to the tube sheet.

Large coefficient of expansion and poor thermal conductivity of structural materials both can increase the strain of large temperature differences. Stress is directly proportional to the product of the coefficient of expansion and Young's modulus. High thermal conductivity reduces temperature gradient between adjacent structural elements and causes more rapid response to temperature transients.

Stresses, no matter how induced,

4 Tubing for Britain's Calder Hall gas-cooled-reactor steam generators use stud fins; may be for longitudinal or crossflow



5 Fin efficiencies and fin tip temperatures with 2600-F gas and 1050-F liquid metal inside schedule-40 stainless-steel tubes

Gas-cooled nuclear reactors pose special problems for their steam generators

cause appreciable strain. Frequent stressing may cause failure from metal fatigue. So thermally induced high cyclic stresses must be avoided or reduced to acceptable levels. Thermal shields do this, though they add to design complexity.

Because of its high failure rate we must carefully design the tube—tube sheet joint. It should have the following features:

1. Can be inspected by good nondestructive testing techniques like radiographing.
2. Made by automatic welding to reduce defects and labor costs.
3. Section through joint shaped for gradual transition in contour and surface-temperature level.
4. Metal flow lines give smooth transition from tube sheet to tube.
5. No crevices in either side of tube joint.

Crevices in waterside of a tube joint permit gradual concentration of corrosive substances from pure distilled water. Crevices in primary coolant side form pockets to collect radioactive material and may be difficult to decontaminate.

Small pockets in the evaporating section can collect superheated steam. These should be avoided to eliminate hot spots that add thermal stresses to local shell areas. Cold feedwater nozzles should have thermal sleeves for the same reason.

Good nondestructive quality control assures proper fabrication of materials and equipment, compatible with specified safety. Costly quality testing must be balanced against possibility of structural failure to gain an economic design.

Tube circuits must be designed to minimize stressing by: (1) differential expansion between tubes and shells (2) differential expansion between individual tube circuits caused by plugged circuit, maldistribution or stratification at part load, or during rapid transients (3) rigidity of single-tube circuit at differing temperature levels in legs or elements of that circuit.

Location, maintenance. All auxiliary reactor equipment should be located in accessible areas. Where the primary coolant is nonradioactive or has short-lived radioactivity, auxiliaries should be brought outside the reactor biological shielding. This might allow making repairs on auxiliaries while the reactor runs, if it has more than one coolant loop.

Major disadvantage of this arrangement lies in the large number and sizes of shield penetrations needed to bring the coolant outside the shield. For pressurized high-temperature gases, small-diameter piping avoids large expansion loops and awkward piping layouts. Taking advantage of this in the heat-exchanger we would use a compartmented design so only a small portion of surface need be isolated until the next scheduled maintenance shutdown. In this design one compartment can be isolated while the rest continue on stream without decreasing the unit's reliability by increased stresses.

All-welded structures are more re-

liable than gasketed joints. Compartmented designs have thinner sections to be cut and rewelded during repairs; they generally are larger overall but not enough to offset the advantages gained.

When an exchanger must be set inside the biological shield, a noncompartmented design will offset the increased shielding cost. Diaphragm-sealed units with bolted cover plates may allow faster maintenance.

Operating cost. A few rules-of-thumb help set preliminary parameters to fix the best design. Pumping gas costs much more than pumping liquids. Pressure losses should be avoided and weighed as a daily charge against operating costs. High gas pressures are favored because of the lower pumping costs.

Using gas-turbine cycles as a yardstick, a 2 to 5% loss in pressure should be economical for a steam generator. Light gases like helium are in the lower range and heavier gases like CO_2 are in the higher range. Minimizing gas flow keeps pumping cost low, but needs higher temperature operating ranges.

Heat-transfer surface can be chosen from bare and extended types: (1) plate, plate and fin (2) bare tube (3) perpendicularly finned tubes (4) longitudinally finned tubes (5) stud fin tubes.

Based on total heat-transfer surface, bare surface costs more than finned surface; but finned surface is not as efficient (Ref 1). For low-pressure-loss designs with low-heat-transfer rates on the gas side, finned surface costs less generally.

Fins on tubes do not hold pressure or bear heavy loads so they may be used at temperatures above those for *Code* stresses. For example, aluminum fins can be used at up to 800 F normal and up to 1000 F for short transients. In an inert gas such as helium, copper can be used up to 1500 F without losing shape.

For high-temperature gases that are not inert to the above materials, carbon steel or low-alloy fins can be used. When conditions and cost warrant, a copper fin clad on both sides with impervious austenitic steel or Inconel can be used. This fin is usually made with a 20%-thick cladding made by rolling a sandwich of cladding and copper to produce a metallurgical bond. Thermal conductivity of such a fin is about the same as aluminum.

High thermal conductivity of fin material reduces unit size and cost by increasing fin efficiency and also lowers fin-tip temperatures. Fin tips are the hottest point on a finned tube and fix the suitability of the material for the operating conditions, Fig. 5.

Plate surfaces. Parallel plates separated by wires or dimples (Ref 3) have been considered for pressurized-water coolant steam generators. Reference 4 gives some unusual designs that may have future possibilities. Present technology does not promise a reliable unit using these designs.

Advantages—(1) A saving in shielding and reduction in volume and weight make a compact unit for mobile installations. (2) Sheet material being less expensive than tubing coupled with good fabrication techniques and designs may yield overall cost reductions.

Disadvantages—(1) Adequate fabrication techniques are not now available. (2) Long temperature ranges in coolant induce large thermal stresses. (3) Manifolding of coolant side becomes awkward. (4) Poor accessibility for repair usually leads to complete replacement of surface. (5) At high temperatures structure stands up better in compression than in tension which depends on brazed joints in tension or bending. Welded on fins seem expensive here.

Bare-tube surfaces should be chosen when high gas-film heat-transfer coefficients make finning uneconomical, especially if fin material must have poor conductivity and high cost.

Bare tubes should be used when gas inside the tubes show economic advantage; internally finned tubes have been developed economically for only a few materials such as aluminum.

Advantages — (1) Suitable with primary coolant on either shell or tube side. (2) Shell-side flow patterns may be crossflow, longitudinal flow or a combination of both.

Disadvantages—(1) High cost of surface in form of tubes. (2) When shell-side fluid has a poor heat-transfer coefficient there is less external surface per cu ft of exchanger volume. (3) If tube material must be costly because of containment, advantage of less expensive material for heat-transfer surface is lost.

Perpendicularly finned tubes include helically wound fins, washers shrunk, brazed or welded on tubes, flued plates with one or more tubes expanded in or brazed to the plates, Fig. 1. These surfaces are used for crossflow of the gas stream over the tubes. Large areas for crossflow can be obtained with minimum number of tubes and longest tubes; so this design is economical for low-pressure gases with minimum allowable pressure losses.

When gas and fins are hotter than tubes, tension-wound helical fins and tubes expanded into plate fins gradually lose heat-transfer contact as temperature gradient from fins to tubes increases. If fin material has higher coefficient of expansion than tube material (steel tubes with copper or aluminum fins) rise in temperature over fabrication temperature may be enough to lose the bond; similarly some soldered or brazed types may not do at high temperatures. A few special brazes, nickel-chrome and silver manganese, have good high-temperature properties. Welding fins to tubes, carefully controlled, can be successful with suitable materials. This introduces a cast structure in the tube wall and reduces tube reliability.

Washers shrunk on tube walls have been used in fired boiler units, but limited material choice and coarse arrangement give little performance gain.

Helically wound, mechanically locked fin with and without a high-temperature braze to seal the bond has been used to heat liquid metals with a high-temperature gas and has withstood many adverse conditions. Fig. 3 shows the mechanically locked fin, an additional seal braze and a stainless-clad copper fin. The fins are mechanically locked by plowing a groove in the tube, tension winding the fin into the groove and forcing the plowed-up metal back against the fin.

Use caution in locking more than one tube to a common set of fins. Differential expansion between tubes caused by maldistribution of tube-side flow at part load have caused some of these to fail. These designs cannot have single tubes plugged without adding additional thermal stresses that reduce the reliability.

Advantages — (1) Finned heat-

(*Continued on page* 176)

HOW TO ORGANIZE YOUR NEW POWER PLANT — 30

Starting and running your condenser's circulating-water system

The author gives precautions to take in running circulating-water pumps and describes the two main types used. He also tells how to deal with trash and air accumulations

By DONALD SWIFT, Ebasco Services Incorporated

When starting up a condenser and circulating-water system, thoroughly inspect all parts to see that they are clean and free from debris. This avoids plugged tube sheets and damaged pumps. See that all pressure manholes and holes for pipe or instrument connections are tightly closed.

Starting up circulating-water pumps requires special care, particularly if the system is empty. Improper starting may cause dangerous water surges. If condenser, piping and pumps are above water level, use priming devices provided.

With a filled water system, start one of the circulating-water pumps. If possible, discharge valve should be closed or nearly closed. Some axial-flow pumps have such a high power requirement at shut-off that motor-starting and protective equipment cannot handle starting currents and still give normal load protection. Discharge valves may then be set ¼ or 1/3 open for starting.

Water should have free access to pump inlet. Suction valve should be wide open, or, in case of a vertical pump, impellers should be submerged.

With a river, lake or sea system, suction and discharge pipes must terminate below water level to pull water into the condensers. With a cooling-tower installation, condenser discharge valve may have to be closed to permit filling the condenser and pump.

In a system with long columns of water in motion or at a standstill, high pressure or vacuum may build up with sudden acceleration or deceleration of the water. Relief pipes or surge tanks on the lines lessen these pressure changes.

Pump precautions. Where two or more circulating pumps run in parallel on a common discharge header supplying one or more condensers, a pump-motor trip-out may cause loss of water flow through the condenser or pump reversal and possible overspeeding. To handle this trouble, install check valves or automatic-closing discharge valves that close as soon as power to pump motor is cut off.

In a cooling-tower system, water in feed pipes to top of tower is heavy enough to cause flow reversal when pumps stop. Unless there is a check valve in the system, pumps run backwards at high speed until water heads in the system equalize. Pumps may be damaged if they are not designed for direction reversal.

If power is turned on while pump is running in reverse, starting current and torque are high for a second or two until pump comes to rest and restarts in normal direction. This may do no harm if not repeated too frequently, but it is certainly not recommended. At the same time, you may get cavitation in the pump suction line as water flow is suddenly halted and pump begins to operate in its normal direction once again.

Air accumulations. Most condensers are set above the water level of the lake, river or ocean that supplies their cooling water. They operate on an inverted siphon principle to use a minimum of circulating-pump power. Vacuum in condenser-outlet waterbox then corresponds to the number of feet above water level minus the friction drop through piping from condenser to lake or river outfall.

As water passes through the condenser tubes it is warmed some 10 to 20 F and then passes into a zone of increasing vacuum. This tends to release dissolved oxygen, carbon dioxide, ammonia or other gas from

the water. Since the condenser is the high point in the system, gas tends to remain there. Accumulated gas blocks off water flow through the upper condenser tubes, thus reducing effective steam-condensing surface area. At the same time, number of tubes active for carrying water is reduced and friction through them is increased. This reduces the amount of water that pump will force through the tubes, and the siphon head available for helping water flow is decreased by the vertical height of the air pocket. All these effects combine to reduce condenser vacuum.

To reduce trouble from air release in circulating-water systems, arrange waterboxes and outlet pipes for a minimum of water turbulence and so that air accumulates in pipes. Thus air is swept along with the water instead of remaining in the condenser. As water becomes colder, it absorbs more oxygen and correspondingly releases more gas as it travels through the condenser. Where vacuum does not exceed 15 to 20 ft of water, trouble is slight; but at 20 to 25 ft, gas release may become bothersome.

Where vacuum in the top of the condenser would be greater than 25 ft because of excessive tides or river-level variations, a seal well is normally installed in the outlet conduit. This well incorporates an outlet weir set not more than 25 ft below the top of the condenser. If water in the outlet conduit falls below the weir top, the water column breaks at that point rather than in the condenser. Thus, excessive vacuum and dissolved-gas release is prevented in the condenser. The cost is the pumping head which is lost in the weir.

Several stations have installed means for reclaiming extra pumping head when using more than 25-ft head between condenser top and river level. Discharge water is passed through a low-head water wheel when vacuum at condenser top becomes excessive. The wheel holds the water up in the condenser outlet. At the same time, it uses available head that would otherwise be wasted to generate power. This scheme is rather complicated. It is only feasible on large installations where there is excessive head loss.

Circulating-water systems are usually primed by air-removal devices operated on the steam or air-jet principle or by a positive-displacement pump. Air-removal points are usually at system high points and hence are suitable for removing gas accumulations. A gage glass installed where gas accumulates indicates when manual removal is necessary.

Under some conditions, removal jets may not pull enough vacuum to remove the gas and may let air enter the system instead. On high-vacuum systems, gas accumulations may need frequent removal. One way to do this is to use a float-operated device that admits the gas into the condenser air-removal system as it accumulates.

Circulating-water pumps are usually the low-head large-volume slow-speed single-stage design. Horizontal pumps may be either single or double inlet style using a volute casing. These pumps may be turned on end to conserve floor space if proper provisions for thrust are made. Vertical, axial-flow pumps also run at fairly low speeds.

Choice of pump depends on water levels, plant design and basement level. The vertical, submerged pumps are always primed, but may be subject to more difficulties from motor overloading and need for providing an even water flow to pump inlets. They are also more difficult to dismantle for inspection. Motor must be removed and the long shaft above the pump must be handled in removing the pump.

Horizontal pumps usually are simply designed and constructed. The upper half of the volute casing can be readily removed, exposing the impeller for inspection. Breaking the flexible coupling permits removing pump impeller for inspection of seal rings, lower bearing halves and lower half of casing. If the water carries much sand or grit, impeller erosion may necessitate rebuilding worn portions by brazing, arc welding or metal spray coating. Treatment depends on the type of material used and the impeller design.

Usual construction employs (1) self-sealed pump glands (except where there is too much grit in the water) (2) bronze or similar non-seizing material for impeller sealing rings (3) sleeve-type bearings with a light thrust surface (4) double-inlet design so that thrust is practically balanced.

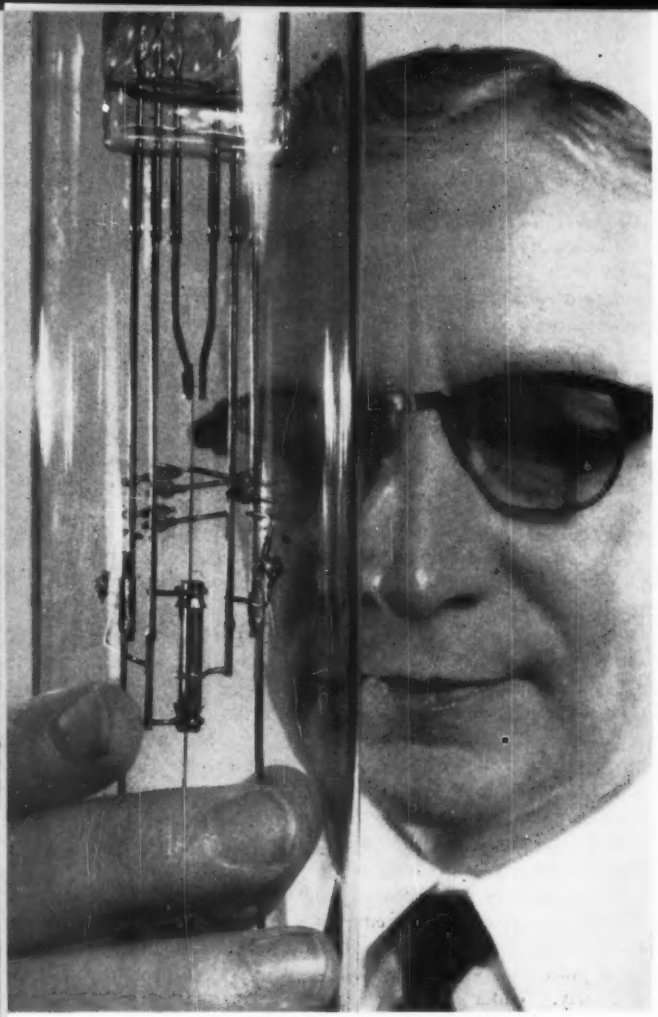
Before starting a horizontal pump for the first time see that it is properly aligned with its driver and that all bearings are lubricated. Gland packing should be in place but well slacked off so it can wear itself in slowly. Water tunnels and passages should be cleaned and inspected, intake screens in place and working. Pressure and vacuum gages and other instruments should be in place. Priming devices, if used, should be in working order.

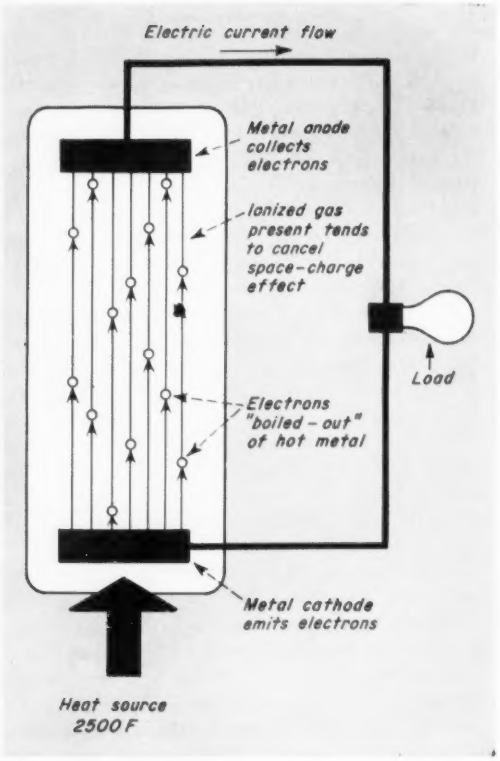
Before turning on power for the first time, turn the pump by hand to be sure it is free. Turn on sealing water to pump glands and open pump suction valve wide so water can enter pump freely. Close discharge valve or have it barely cracked.

After pump and condenser are primed, start pump for a few seconds several times to see if it behaves properly. If it does, you can leave it in service. Then crack open the pump-discharge valve so water slowly fills condenser and conduits. If everything is tight and no leaks appear, gradually increase flow to maximum.

At this time, check motor current with an ammeter. Water flow-path resistance may be less than calculated, causing high water flow and possible heavy motor overloading. Throttling pump discharge valve may reduce flow and power requirements to a point reasonably close to normal. If flow and suction lift are both high, rumbling and cavitation may appear in the pump. You can partially relieve this by bleeding a small amount of air into the pump suction line through a ¼- or ½-in. valve or other opening.

If motor is not seriously (*Continued on page* 196)




Electric current flow
Metal anode collects electrons
Ionized gas present tends to cancel space-charge effect
Load
Electrons "boiled-out" of hot metal
Metal cathode emits electrons
Heat source 2500 F

HEAT SOURCE in lab model is electric current, fed to emitter for 1/120 sec, then turned off for similar period

THERMIONIC CONVERTER, held by GE's Dr V C Wilson, uses center-wire emitter surrounded by collector cylinder

Heat-to-electricity: A new approach

Electrons given off from a 2500-F cathode are collected for direct use as an electric current. Developed by GE, the experimental unit boasts 8% efficiency, promises 30%

Scientists have been searching for simple ways to convert heat directly to electricity ever since the usefulness of electricity was first discovered. Most attempts at direct conversion have used either thermocouples or thermogalvanic cells. However, nothing developed so far, including General Electric's new thermionic converter, offers serious competition to present methods of producing large amounts of electricity. The thermionic converter is one of those developments that should be judged for the knowledge it provides, not yet as a commercial product.

New converter combines several known scientific principles in a unique manner. The two electrodes within the tube-like device are maintained at high, but different, temperatures. The hotter cathode operates at about 2500 F. Success of this device hinges on introducing an ionized gas between the electrodes. These positively charged particles tend to cancel out effect of negatively charged electrons, permitting electron passage from cathode to anode. Thus the old problem of an electron being repelled when surrounded by electrons in a vacuum or gaseous medium, called space-charge effect, has been licked.

Efficiency of the thermionic converter is about 8%, with a hoped for ultimate figure of 30%. When this latter goal is realized, the emitting cathode will be sized for 10 watts per sq cm or 100 sq cm for a 1-kw output. Present laboratory model has an output of 3 watts per sq cm which translates into ½ watt at 0.8 volts. Dc supplied from such a device will probably never exceed a potential of 2 or 3 volts.

Improved fuel cell makes fresh bid as power producer

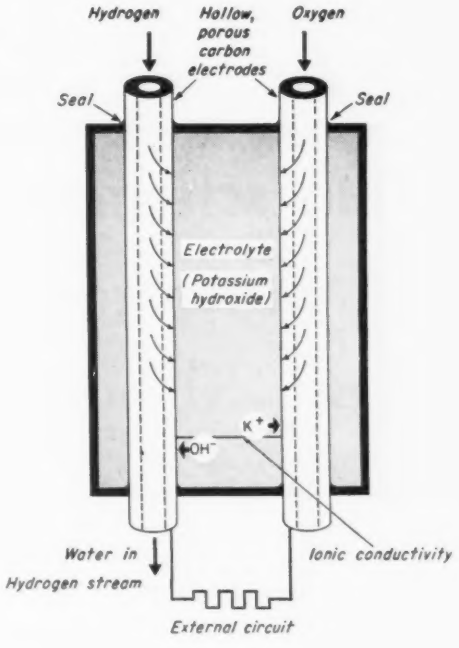
While the thermionic converter, left, is making its contribution to the field of electric power production, progress is reported in the fuel cell area. National Carbon Co's scientists have developed an improved fuel cell, propose it as a possible economic power producer for some limited applications in the kilowatt range.

Designed to operate at 120 to 140 F, at about atmospheric pressure, the cell is claimed as the first that doesn't depend on high temperatures and pressures for efficient operation. Cell efficiency falls between 65 and 80%.

Unlike conventional batteries, fuel cells remain essentially unchanged during their life. They produce electrical energy from chemical fuels, supplied as needed. Housed in a sealed jar, the fuel cell is fed hydrogen and oxygen through hollow porous carbon electrodes. Electrochemical reaction of gases at these electrodes produces electric current, leaving only water.

National Carbon's researchers point to the optimum fuel cell design as one producing about 1 kw at 1 volt from a packaged unit 1 cu ft in volume. By parallel-series arrangements many combinations of voltages and currents can be had. Basically, the fuel cell is most desirable for high-current low-voltage applications.

In operation, hydrogen and oxygen enter the cell through hollow electrodes, diffuse through porous carbon coming into contact with potassium hydroxide electrolyte. Electrochemical reaction at hydrogen electrode produces water and electrons. Latter flow through an external circuit, return to the cell, are accepted at the oxygen electrode. Ionic conductivity through the electrolyte completes external electrical circuit.



One major limitation on further practical use of the fuel cell hinges on a low-cost supply of hydrogen. Both solar and nuclear energy are being considered for the job of decomposing water, economically, into hydrogen and oxygen.

One difference between the new thermionic converter and the thermocouple lies in means for separating electrodes. Converter metals are separated by a gas at low pressure. Current flows between the electrodes, but less heat flows than in a thermocouple. Thus converter electrodes can be at different temperatures, greatly improving efficiency.

Thermocouples have been used for years to measure temperature differences. In simplest form the thermocouple is made up of two dissimilar wires junctioned at one end with open ends connected to a temperature indicator or electronic control. In some instances semiconductors with appropriate thermal and electrical properties are used in thermocouples instead of familiar dissimilar metals.

Relay stations, as part of telephone transmission systems, are often located in remote areas. The Bell Telephone Labs have developed a thermocouple device to power transistor-type amplifiers used in these stations. Even though efficiencies are low, the scheme is practical since amplifiers need only a watt or two of power. Only maintenance is infrequent replacement of a gas tank supplying fuel to heat the junction.

The Russians use a thermocouple device for generating electricity in kerosene-powered radios. Here again, low efficiency can be tolerated. Reported efficiencies are about 0.75%. One difficulty in improving thermocouple efficiency lies in finding materials that are good electrical conductors but poor conveyors of heat. These properties, along with their thermoelectric-power, determine the merit for thermocouple materials.

Other devices have been used or proposed to convert light into electricity (photoelectric cell, solar battery) or chemical energy into electricity (fuel cell). But efficiencies reached have kept them out of the picture as power producers.

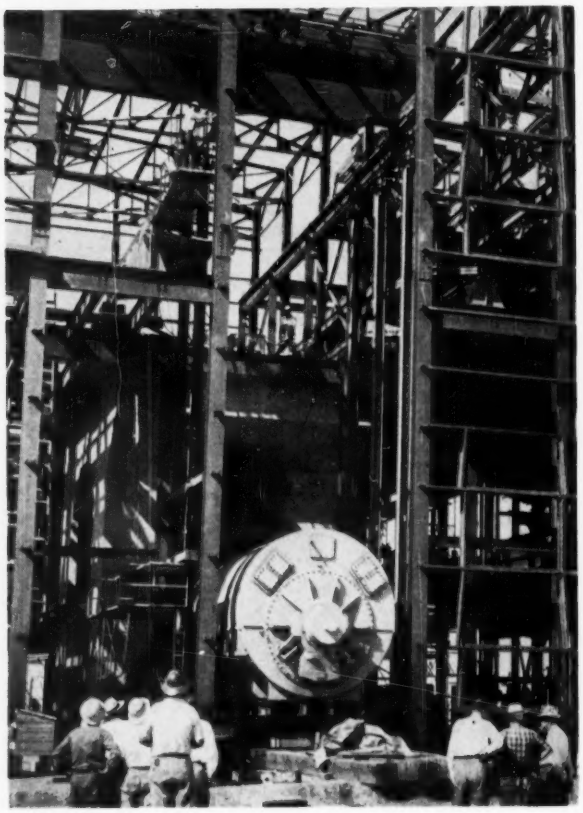
Future for thermionic converter is still hazy. Conceivably, nuclear fusion might be the heat source. Solar scheme could be developed using lenses and mirrors to arrive at high temperatures needed. The crystal ball might show such devices as toppers for a steam turbine.

Key steps in raising generator from ground . . .

Lift-slab scheme raises generator 40 ft in 20 hours

Hydraulic-jack technique, used for lifting poured floors into final position, did the trick when a 200-ton generator for Tucson's Station No. 4 had to be set on its pedestal

By E R PETERSON, Project Manager, Sanderson & Porter



START OF LIFT sees hydraulic jacks atop the lifting columns yet inside the building steel, close to each side of generator

Practical limits

The use of lift-slab, like every other construction technique, must be evaluated. Most important current use comes in erecting a structural frame. However, raising and lowering bridges, smokestacks, and steel-floor framing have all been considered. Method has been used quite successfully with bridges. Height to which a structure can be raised or lowered is still undetermined.

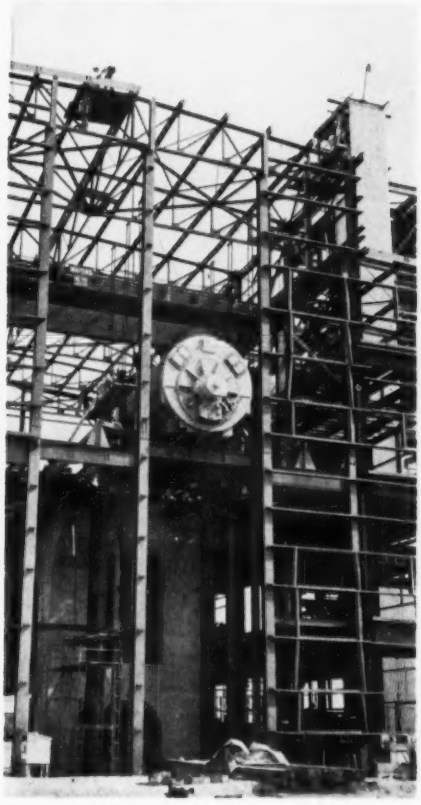
One economical limit is size of job. Costs in transporting equipment and setting it up are practically the same for a single or multislab operation.

Setting large central-station generators onto their final resting place is a tough rigging job no matter how you look at it. And the job is getting tougher. Why? Simply because as unit size increases, the above-grade height of pedestal increases . . . at least in some southwestern plants. Trend to shipping generators, often exceeding 200 tons, completely assembled and ready for final installation compounds the problem. More conventional rigging methods call for cribbing plus hand jacking or providing a traveling crane with supports big enough to handle the 200-ton-plus load. And chances are the crane would never see service this heavy again for plant's normal life. That's why the lift-slab technique was tried.

Lift-slab is a method of erection. As generally used in building construction, upper floors and roof are poured at ground level with the building's ground floor serving as a basic form. After curing, slabs are lifted by hydraulic gear to their proper height. Once the precast floors are in final position they are permanently fastened to the building columns. Lift-slab equipment includes (1) hydraulic pumping unit (2) hydraulic lifting-jack (3) hydraulic control board.

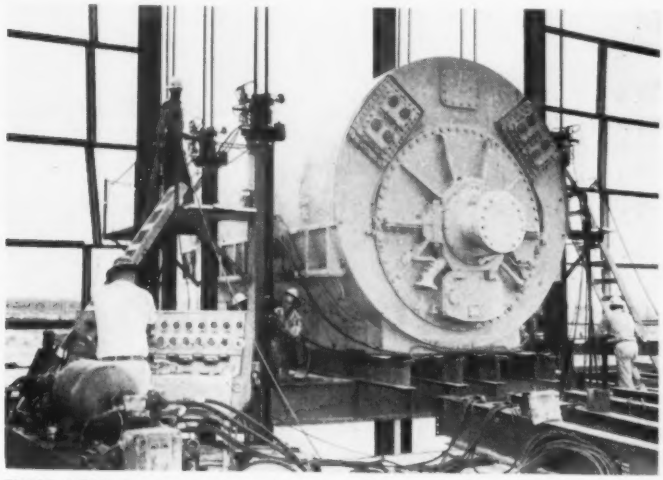
New use for lift-slab came about when the first generator for the new Station No. 4 of the Tucson Gas, Electric Light & Power Co in Tucson, Arizona had to be lifted 40 ft onto its pedestal. To do the job, a lifting framework (six columns, three lifting beams, six holding collars) was built alongside pedestal. Generator was supported on steel beams resting on lifting beams. Latter took the load as the generator was raised from

. . . to final pedestal height



END OF LIFT comes a few feet above the pedestal top. Result was a safe, fast job

WHILE RAISING, holding collars rest loosely around the columns. They are temporarily bolted to columns at about midpoint in lift while rods are changed

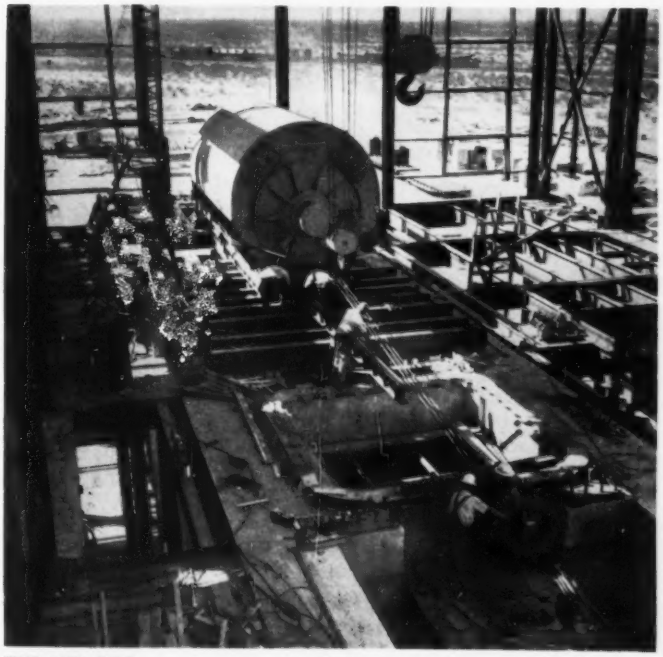


FINAL HEIGHT is point where holding collars are fastened to columns before releasing lifting equipment. Note control panel, hydraulic pump unit, jacks

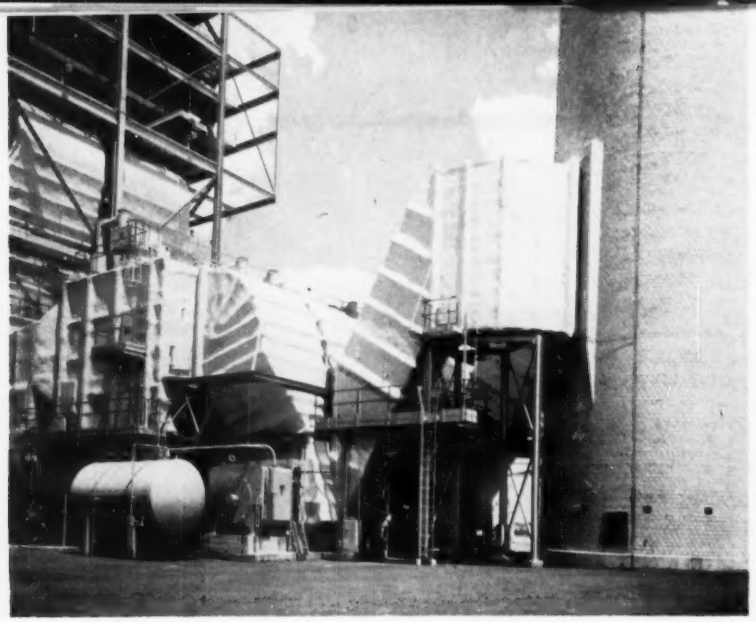
grade to height practical for skidding unit over onto foundation.

Lift-slab jacks (Vagtborg Lift-Slab Corp, Los Angeles, California) were placed atop the lifting columns with rods extending to underside of lifting beams. Because of 40-ft height for generator lift, several rod lengths were coupled. Generator was temporarily supported about half-way up with holding collars while changing rod lengths; top coupling reached the jack at about half travel. Lifting was started again, and carried on until generator was a few ft above foundation. Here it was held by lifting collars while jacks and rods were removed. Machine was then skidded over on its foundation.

The dismantled steel lift-frame was stored for use again with tomorrow's generators; further proof the technique is quite practical.



THE BIG SKID onto generator foundation is simply a matter of providing greased skid beams ahead of the machine and then applying pull-power



New station's automated system is a top example of . . .

How to cope with flyash disposal

By C A GALLAER, Buell Engineering Co Inc

Getting rid of six tons of flyash per hour is no small feat in any engineer's book. A dust-collecting system has to stay on the ball to do it. Add automation to both flyash and bottom-ash handling, taking the job completely out of human hands, and you've got a crack setup. Small wonder the Long Island Lighting Co is proud of these features of their new 180-mw E F Barrett Station.

First-stage cyclones and second-stage electrostatic precipitators handle to 518,000 cfm of flue gas when the 1,150,000-lb-per-hr boiler operates at continuous capacity with high-volatile bituminous coal. Dust-collecting system's efficiency is over 95%.

Control over the entire ash-removal system stems from a master switch in the control room. In addition to doing its present job, the switch is set up to mastermind a duplicate system in a soon-to-be-built twin power plant. Beyond that, it provides for the day when nearby disposal areas will be completely filled and flyash will have to be discharged directly to trucks for removal.

To operate system, control engineer merely positions master switch to suit conditions. On "automatic," hoppers empty in predetermined order (sequential emptying once each shift is normal procedure) with outlet valves automatically opening and closing as required to discharge loads. An illuminated dial on the board indicates which hopper is discharging at a given time; numerals light up as corresponding hoppers empty.

On "by-pass," master switch sends system through the same sequence, but no hoppers unload. Throwing switch from "by-pass" to "manual" will empty any hopper selected when its number comes up on the illuminated dial.

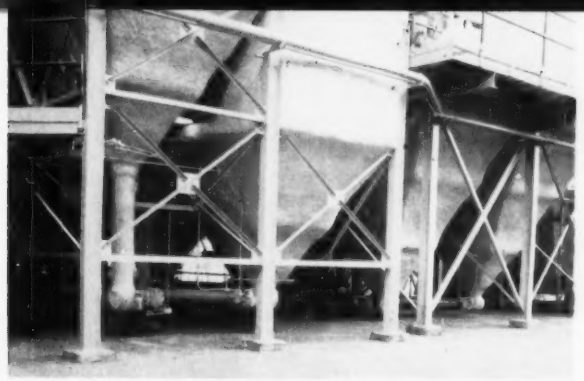
Control panel also has "on-off" switches for pumps supplying water to a vacuum-producer (for conveying flyash and bottom ash) and instruments showing water pressure, vacuum (in. Hg) and pump-motor amp.

Vacuum producer is a vertical venturi ringed internally with downward-directed water nozzles. Vacuum created by high-velocity jets from nozzles pulls ash through hopper outlet valves. Water and ash discharge into an air-separator tank, then flow by gravity to fill areas. Vacuum holds at about 20 in. Hg during hopper discharge, drops to about 5 in. when hopper empties. At this point the sequence control automatically closes empty hopper valve, waits for vacuum build-up, then opens next hopper valve.

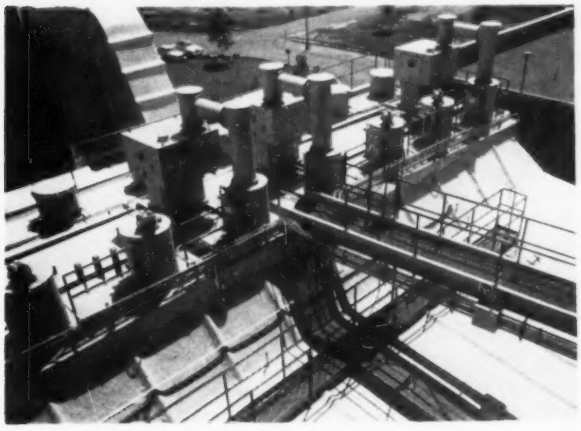
First-stage dust collector is made up of 4% cyclones in one large insulated housing. Cyclones are split into two side-by-side banks; each bank subdivides into six groups of four cylinders. A separate split-duct manifold supplies each group, provides for tangential entry without gas-pressure drop due to direction change.

Each group discharges into a 280-cu-ft hopper equipped with an air fluffing system—perforated pipes that discharge compressed air whenever hopper outlet valve is open.

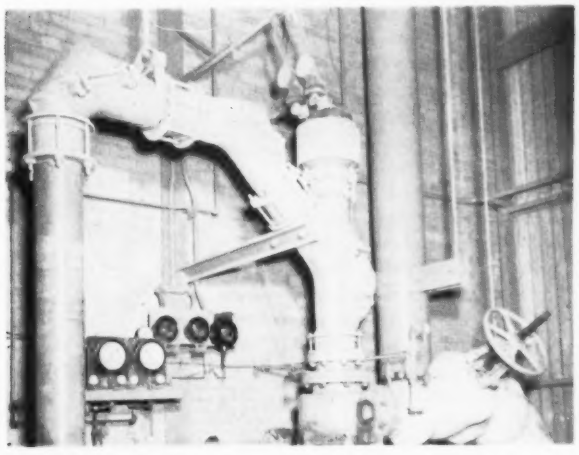
In the cyclones, centrifugal force throws out the dust particles which drop into the hopper below. Cleaned gas rises at cyclone's center, leaves through an outlet at top. A rectangu-



HOPPERS collect ash from the cyclones and electrostatic units, are automatically dumped in sequence or singly by master control



HEATED CABINETS house transformer-rectifier units mounted atop precipitator. Outdoor arrangement avoids long high-voltage leads



VACUUM PRODUCER. Water from insulated pipe, *right*, flows through venturi, *center*, creates vacuum, draws ash from the hoppers

lar port in the upper part of the collector ups efficiency by getting rid of fines that tend to gang up in eddy currents at this spot. These fines bypass the routine particle pathway, travel directly to main body of dust in collector's conical section.

Though cleaned of heavier particles by the cyclones, gas stream is still loaded with extremely fine dust as it leaves. Here the electrostatic precipitator takes over. Consisting of alternate rows of emitting (high dc negative voltage) electrodes and collecting electrodes (grounded parallel metal plates), its purpose in simplified form is to (1) negatively charge entering dust particles (2) attract them to collecting electrodes and (3) dump them into hoppers. Each precipitator has two independent sections and each 36-pass section handles gas from one bank of cyclone collectors.

Individual 20-kva 66-kv power packs (transformer-rectifier and control cabinet) serve two parallel h-v units in each section. Located outdoors on top of precipitator and directly above units they serve, the transformer-rectifiers step up plant ac voltage and convert it to dc needed for the emitting electrodes. Arrangement eliminates need for long h-v cables: the heated insulator cabinets prevent condensation during shutdown and subsequent possibility of shorts at start-up.

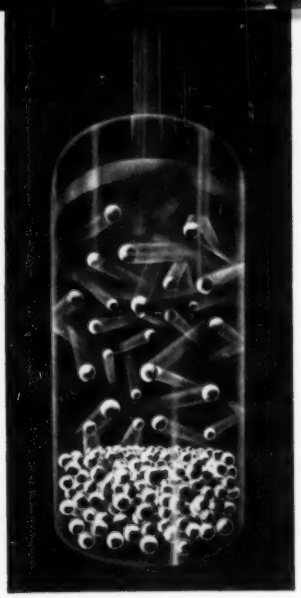
Power supply feeds from respective control cabinets in boilerhouse. Each cabinet, with grounded casing and safety-key interlock, houses "on-off" controls for rectifiers, rapping motors and heaters, plus transformer primary current, output voltage, rectifier current indicators.

Rectifier polarity may be positive or negative at start-up of any mechanical rectifier. However, polarity must be negative during operation. If positive, usual procedure is to manually throw a switch to reverse polarity. At the Barrett Station, if polarity isn't correct at precipitator start-up, it's automatically reversed.

In operation, ash deposits build up on both emitting and collecting electrodes. To knock ash loose, a system of motor-driven rapping mechanisms comes into play. The four suspended h-v emitting units are individually rapped about once a minute by their own ¼-hp rapper motors. A ½-hp rapper motor serves each of the two 37-panel collecting electrode sections; raps panels individually, one after the other.

Station's clean stack gives evidence of system's efficient performance. Complete automation relieves operating personnel from time-consuming duties normally connected with flyash and bottom-ash removal and disposal. In step with today's trend toward higher efficiency in operation and maintenance and the drive to combat air pollution, the Barrett Station setup is a prime example of how to handle a tough problem.

THERMO REFRESHER NO. 15



By B G A SKROTZKI, Associate Editor

Holding down losses makes energy-transmitting systems practical. Here's how multistaging improves compressor performance and how air engines convert internal energy to shaft work to make . . .

Compressed-air systems pay off

Last month we studied the basic types of compressors, with and without clearance. We learned that compressors can run between the limits of constant-T and constant-S processes. The first needs the least work input W—all the work immediately leaves the gas as heat Q through the cylinder wall. Water jackets on some actual compressors absorb this heat.

In the constant-S compressor all the work done stays in the compressed gas as internal energy. This compressor uses the maximum work input. Actual compressors run somewhere between these limits on a polytropic compression—a part of the work being rejected as heat, remainder staying in gas as internal energy.

In most compressed-air systems it's difficult to keep the h-p air hot; when the air reaches its point of use it usually has cooled to the ambient temperature. For this we should use a constant-T compressor and save the work that goes to raising internal energy of the air. Unfortunately, we can't build such a compressor, but we can approximate its economy by multistaging.

Multistage compressors. We have been studying single-stage compression up to now. But gases may be compressed in steps or stages in a series of cylinders. Fig. 1*c* shows the arrangement of a 2-stage compressor with intercooler; 1*b* shows the P-V relations with zero clearance.

Free air enters the l-p cylinder during admission stroke *1-2*. Air compresses to an intermediate pressure at constant-S from *2* to *3*. During *3-4* the air discharges to the intercooler. The air gives up heat Q to the intercooler water and cools back to atmospheric temperature. This reduces the specific volume of the air —when the air enters the h-p cylinder on the admission stroke it occupies less volume than it had during discharge from the l-p cylinder. From *5* to *6* the compression is completed at constant-S and the air discharges to the h-p system during *6-7*.

In Fig. 1*b* the *2-A* is a constant-S process for a single-stage compressor working directly between atmospheric and h-p system pressure levels. Process *2-B* is at constant-T needing minimum work input, the ideal we try to approach by this 2-stage intercooled compression. Hatched area *3-5-6-A* measures the work input saved by intercooling. Area *1-2-3-4* measures the work input W_L to the l-p cylinder and *4-5-6-7* the work input W_H to the h-p cylinder.

How do we choose the intercooler pressure P_3? As we make P_3 approach P_2, the work-saved area *3-5-6-A* becomes a narrow crescent paralleling *2-A* and finally disappears. State *5* must always lie on the constant-T process *2-B*. As we make P_3 approach P_6 the work-saved area becomes a shorter and shorter oblique rectangle until it disappears.

Proper level for P_3 can be fixed by taking the formula for total work input $W = W_L + W_H$ and finding where it becomes a minimum. Complete equation is:

$$W = \frac{nP_2V_2}{1-n}\left[\left(\frac{P_3}{P_2}\right)^{\frac{n-1}{n}} - 1\right] + \frac{nP_3V_5}{1-n}\left[\left(\frac{P_6}{P_3}\right)^{\frac{n-1}{n}} - 1\right]$$

Note that:

$$P_2V_2 = P_3V_5 = RT_a$$

since they all lie on the constant-T_a line which is usually atmospheric temperature. By usual differential analysis (see any standard thermo text) of the work equation we find that for minimum W the compressor pressures must be in the relation:

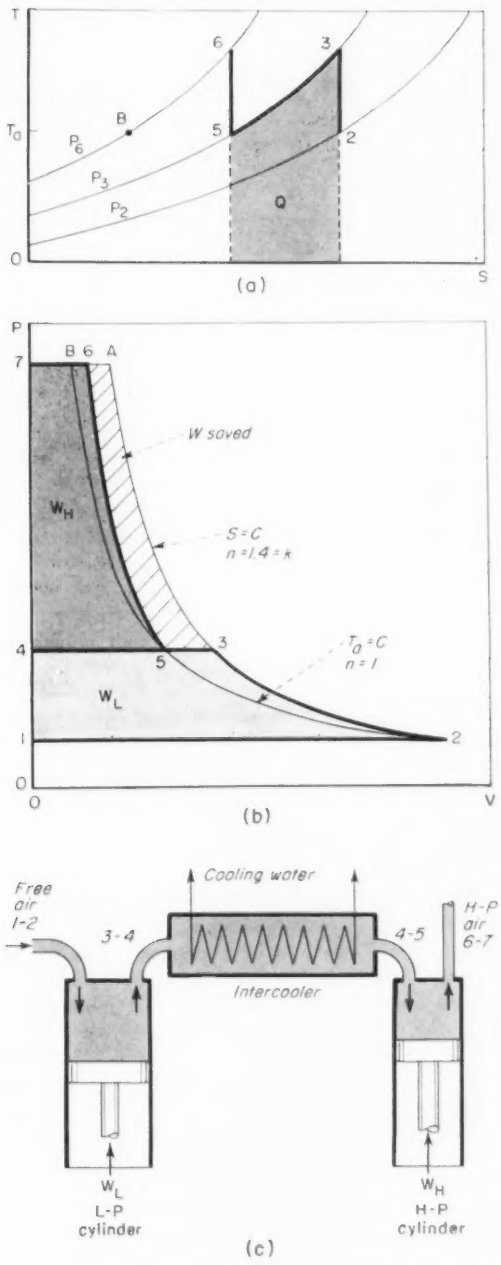
$$P_3 = \sqrt{P_2P_6}$$

For this condition the work done in each cylinder is equal:

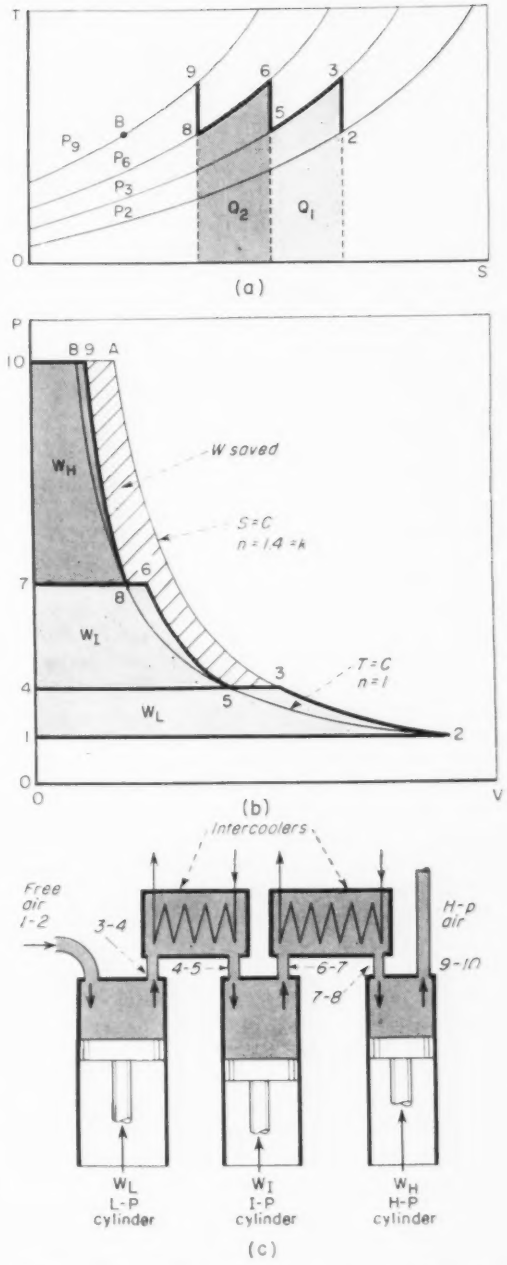
$$W_L = W_H$$

This is shown in Fig. 1*b*, where W *saved* is at the maximum.

Fig. 1*a* shows the state variation



1 Two-stage compression with intercooling cuts shaft work input, avoids too high a temperature of discharged air

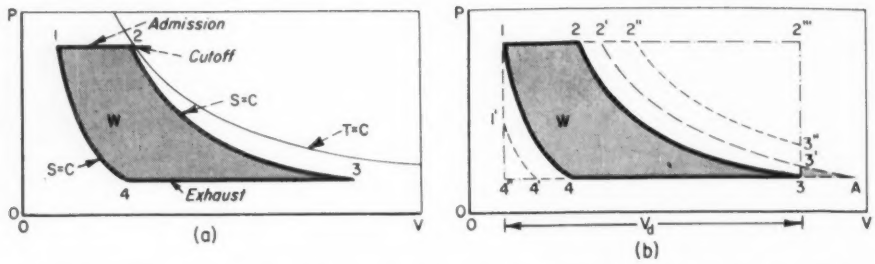


2 Three-stage compression with two intercooling stages reduces work input more—used on higher-pressure air

for the 2-stage intercooled compressor on T-S co-ordinates. Remember that on the T-S chart we can't show the admission and discharge actions in the cylinder, all we can see is the variation in state for a fixed mass of air.

From 2-3 we have the constant-S compression of one lb air from P_2 to P_3. During 3-5 the air cools at constant pressure giving up heat Q in the intercooler. Then during 5-6 the air compresses at constant-S to final pressure P_6. Note: $T_5 = T_2$ the atmospheric temperature. (For minimum work input that we show here $T_6 = T_3$.) By passing the air leaving the l-p cylinder through the intercooler we get the air in the same state 5 that it would have had if it had been compressed at constant-T. This means that Q in Fig. 1*a* equals W_L in Fig. 1*b*.

If we had an aftercooler following



3 (*a*) Ideal air engine expands pressurized air to atmospheric pressure to produce work *W* per cycle. (*b*) Actual air engines use variable cutout to vary the net air work output

the h-p cylinder to cool the h-p air back to atmospheric temperature at constant pressure as at *B* in Fig. 1*a*, the area under *6-B* would be equal to W_H, work in the h-p cylinder.

Three-stage compressor. As final air-pressure level rises it becomes more economical to use extra stages of compression. Also, for given total pressure rise we can decrease the work input by increasing the number of stages and intercooling between them.

Fig. 2 shows the circuit and P-V and T-S diagrams for 3-stage compression. Here we have the problem of finding the intermediate pressure levels that give minimum total work input. By an analysis similar to that for Fig. 1 these pressures must be:

$$P_3 = \sqrt[3]{P_2^2 P_9} \quad P_6 = \sqrt[3]{P_2 P_9^2}$$

For this condition: $W_H = W_I = W_L$

For the conditions stated in Fig. 2, which are the optimum, heat Q_1 given up in the l-p intercooler equals W_L work input to the L-P cylinder and heat Q_2 equals W_I work input to I-P (intermediate-pressure) cylinder. If we had an aftercooler following the H-P cylinder to cool the h-p air to *B* in Fig. 2*a*, the area under *9-B* would equal the work of the H-P cylinder W_H.

Aftercoolers are used in some compressed-air systems to condense out the water vapor carried in with the free air. If this vapor condenses out in the h-p air lines as the air cools it can cause water hammer and give considerable trouble in the air-driven tools.

Air engines. Compressed air acts as an energy-transmitting medium. Compressors "generate" the energy in the air, engines use the energy in the air to reproduce mechanical work. In a literal sense we can call air engines reversed compressors. They have the same essential working elements, a piston reciprocating in a cylinder. They differ in type and control of admission and exhaust valves. Compressors need a "flap" valve that works entirely from differences in gas pressure on its two sides. For normal operation they need no linkages with the piston. On engines, however, the valves must be operated through linkages which are usually synchronized mechanically with piston position.

Fig. 3*a* shows the ideal P-V variations in an air engine cylinder. At *1* the cylinder holds pressurized air in its clearance volume. The admission valve opens to let in air from the h-p line at constant pressure. At *2* (cutoff) the admission valve closes and the air expands at constant-*S* to state *3*, atmospheric pressure. At *3* the exhaust valve opens and the piston forces the air from the cylinder at constant atmospheric pressure to atmosphere. At *4* the exhaust valve closes and the remaining air is compressed adiabatically (constant-*S*) back to *1* to repeat the cycle. For internally reversible processes and flows the net area *1-2-3-4* measures the net work *W* done by the air on the piston. The analysis follows just the reverse of that done for the compressor with clearance (Part 14, POWER, Dec 1957, pp 112-115).

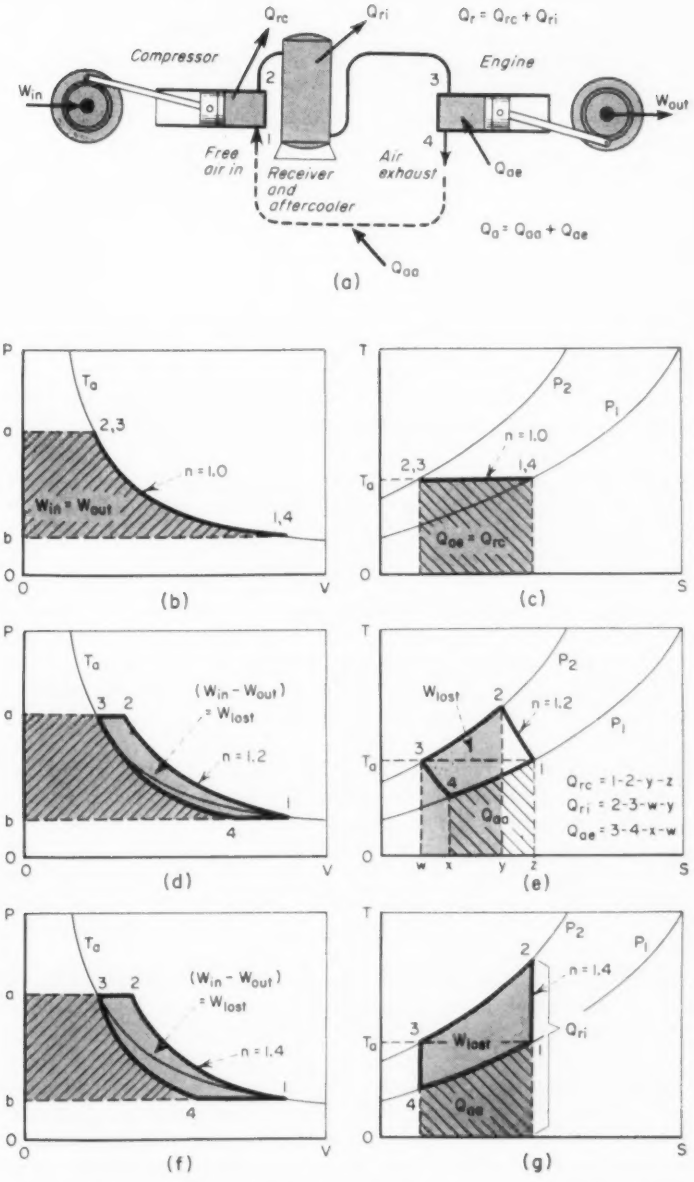
The cycle in Fig. 3*a* shows the ideal having maximum efficiency, because we expand and compress the air at constant-*S*. We can, however, get more work from a particular cylinder by varying the timing of valve openings and closings as shown in Fig. 3*b*.

We could delay cutoff to *2'* to take in a greater mass of air before expansion, then expand at constant-*S* to *3'* at the end of the piston stroke. Since the air still has a higher pressure than the atmosphere, some of the air blows out of the cylinder when the exhaust valve opens until the pressure drops to atmospheric at *3*. The piston then forces the rest of the air out of the cylinder at constant pressure to *4* where the valve closes and compresses the clearance air. By this operation we get a net work measured by the area *1-2'-3'-3-4*, an increase measured by area *2-2'-3'-3*.

We lose some work by incomplete expansion to atmospheric pressure. The amount is small as shown by the small toe, *3'-A-3*. But this loss grows the longer we delay cutoff. At *2"* we would expand to *3"* with a great gain in work per cycle, but increasing loss in efficiency because of more pressure air blown off to atmosphere at beginning of exhaust.

We can also increase work per cycle by delaying closing the exhaust valve as in Fig. 2*b*. If we closed at *4'* the clearance air would compress to *1'*. Opening the admission valve then forces h-p air into the cylinder to raise the pressure to *1*, but no work would be done on the momentarily stationary piston—any motion of h-p air that does no work causes a loss in efficiency of energy use.

The greatest work per cylinder (at the least efficiency) would be realized by the full-admission cycle *1-2'''-3-4"*. Here we simply let the h-p air act on the piston for its full stroke V_D. Then open the exhaust valve to let the full-pressure air blow to atmosphere until the cylinder pressure drops to atmospheric. Then return the piston to force out the remaining air at atmospheric pressure for the full stroke. Opening the admission valve at *4"*



4 Simple compressed-air system could work on constant-temperature processes, *b* and *c*; or on polytropic processes, *d* and *e*; or on constant-entropy processes, *f* and *g*. As *n* rises above 1.0, work lost keeps growing quite rapidly

forces h-p air into the cylinder with the piston stationary. This cycle is used often on small tools or on tools needing maximum piston pressure for the full stroke.

Compressed-air system. Now that we know the major components of a compressed-air system, let's see how they work together. Fig. 4*a* shows the hookup for a single-stage compressor, an aftercooler and receiver shown as a single unit, and a single-stage air engine. Free air enters the compressor, flows through the aftercooler-receiver, then through the engine and discharges back to atmosphere.

For easy analysis let's consider this a closed air circuit as shown by the dotted line. For steady flow the *mass* of air exhausting from the engine always equals that entering the compressor, even though their temperatures differ. We can consider the atmosphere as a heat exchanger in the equivalent closed circuit.

The receiver acts as a storage reservoir for the h-p air—it keeps a reserve of air for the engine whose demand may vary widely. This allows the compressor to run at a steadier pace.

Energy flow into and out of the system takes two forms, work and heat. Prime energy source, Fig. 4*a*, for the system is W_{in} to the compressor shaft. The compressor cylinder and receiver-aftercooler usually reject heat to the atmosphere, Q_r. The engine produces the major product of the system, W_{out}. Usually the engine and atmosphere introduce heat into the "closed" system as Q_a.

According to the first law of thermodynamics, these four energy flows must always be in balance, for steady air flow through the system:

Energy in = energy out

$W_{in} + Q_a = W_{out} + Q_r$

Constant-*T* system. Fig. 4*b* and *c* show the events for an ideal constant-*T* compressor and engine with an atmospheric temperature T_a. W_{in} the gray area, raises air pressure from *1* to *2* while Q_{re}, shaded area, flows through the compressor-cylinder walls to atmosphere. This system does not need an aftercooler. Air expands in the engine from *3* to *4* while it absorbs Q_{ae} from the atmosphere, hatched area, through the engine cylinder walls and produces shaft work W_{out}, hatched area. For reversible processes:

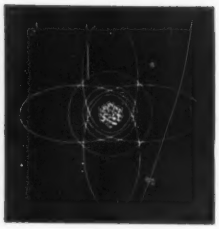
$W_{in} = W_{out} = Q_{ae} = Q_{re}$.

This assumes, of course, there are no pressure drops in the system.

Polytropic system, Fig. 4*d* and *e*, gets nearer to the conditions of a practical system, with polytropic process having $n = 1.2$. The gray area W_{in} compresses air from *1* to *2* while the air rejects heat Q_{re} to atmosphere through compressor cylinder walls. Q_{re} equals area *1-2-y-z* in 4*e*. In the aftercooler-receiver the air rejects heat Q_{ri} equal to gray area *2-3-w-y*.

In the engine, the air expands from *3* to *4* while absorbing heat Q_{ae} equal to area *3-4-x-w* and produces work W_{out}, hatched area. Because the

(*Continued on page* 184)



Nuclear notes

By B G A SKROTZKI, Associate Editor

December 2, 1957, just 15 years after the first self-sustained nuclear chain reaction was achieved in Chicago, the first large scale nuclear-powered central station went critical in Shippingport, Pa. During start-up the reactor produced about 25 kw-heat. Several weeks will elapse in testing reactor components before turning steam into the 60-mw turbine-generator feeding the Duquesne Light Company system.

How much uranium? With most of the world not yet explored, world reserve of uranium stands at about 25 million tons. Over 20 million tons are locked in low-grade deposits of shale, phosphate, etc, yielding less than ½ lb U per ton of ore. Free-world reserves hold over one million tons uranium in high-grade deposits that can be processed for about $10 per lb U. Theoretically, one ton uranium has same energy as 2.7 million tons coal. But at 1% burn-up this drops to 27,000 tons coal. This makes free-world reserves about equal to 27 billion tons coal, with certainty that this will more than double as exploration activity expands. This compares with U.S. coal reserves of 950 billion tons—most of it recoverable only at high cost. Improvement in burn-up percentage will increase energy value of uranium.

Vallecitos DBWPR (Developmental Boiling Water Power Reactor) went critical on August 5, 1957. It is the first privately-financed power reactor to be run. General Electric Company built the reactor which supplies steam to a 5000-kw turbine-generator owned and run by Pacific Gas & Electric Company. This California plant went on the line on October 24, 1957. The dual-cycle reactor will give advance experience on the 180-mw unit being built for Commonwealth Edison Company. Flash steam at Vallecitos exhausts to atmosphere instead of entering turbine at low pressure.

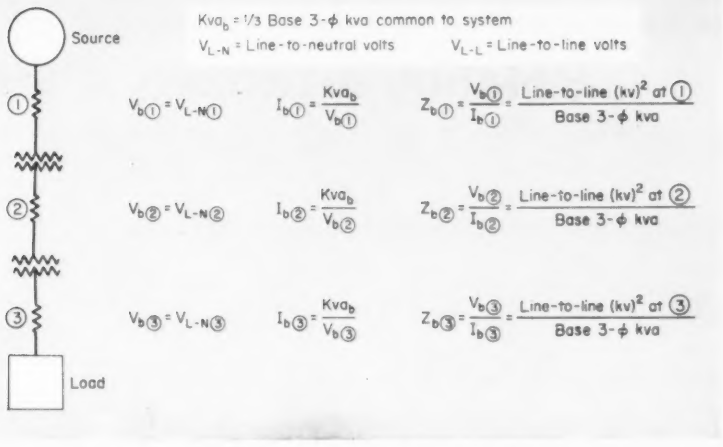
Zirconium price tumbles third time in four years according to The Carborundum Metals Company. High-grade zirconium sponge for nuclear reactors now costs $7.50 per lb for 1000-lb lots. In 1953 it cost $22.00 per lb

Magnetohydrodynamics comes out of its ivory tower to possibly put on overalls and work in fusion reactors and hypersonic flight. This science makes it possible to exert forces on fluids without solid surfaces and avoid high heat transfer. Magnetohydrodynamics studies the interaction between magnetic fields and electrically conducting fluids—grew out of finding answers to astrophysical problems.

Atomic merchant ship contract has been awarded to New York Shipbuilding Corp of Camden, N. J., by the Maritime Administration, U.S. Department of Commerce and the AEC. Babcock & Wilcox Co will build the pressurized-water reactor. Ship will be ready by 1960. The 21,800-ton vessel will be 587-ft long and have normal driving power of 20,000 shp to go 20 knots. Steam turbine will drive single propeller shaft.

Five working reactors producing electric power have gone critical during 1957, late 1956. Shippingport and Vallecitos are reported above. Experimental Boiling Water Reactor at Argonne National Laboratories in Lemont, Ill., was made critical on Dec 21, 1956, generated 5 mw-elec on Dec 29, 1956. Army Package Power Reactor went through its preliminary tests during March 1957 to produce 1855 kw-elec, at Fort Belvoir, Va. Sodium Reactor Experiment at Canoga Park, Calif, with 6.5-mw electric capacity produced its first output on July 12, 1957. This sodium-cooled graphite-moderated reactor was built by Atomics International under the AEC 5-year program.

By A H KNABLE
Allis-Chalmers Mfg Co


Source
Load
Kva_b = 1/3 Base 3-ϕ kva common to system
V_{L-N} = Line-to-neutral volts
V_{L-L} = Line-to-line volts
$V_{b①} = V_{L-N①}$
$I_{b①} = \frac{Kva_b}{V_{b①}}$
$Z_{b①} = \frac{V_{b①}}{I_{b①}} = \frac{\text{Line-to-line (kv)}^2 \text{ at } ①}{\text{Base 3-}\phi \text{ kva}}$
$V_{b②} = V_{L-N②}$
$I_{b②} = \frac{Kva_b}{V_{b②}}$
$Z_{b②} = \frac{V_{b②}}{I_{b②}} = \frac{\text{Line-to-line (kv)}^2 \text{ at } ②}{\text{Base 3-}\phi \text{ kva}}$
$V_{b③} = V_{L-N③}$
$I_{b③} = \frac{Kva_b}{V_{b③}}$
$Z_{b③} = \frac{V_{b③}}{I_{b③}} = \frac{\text{Line-to-line (kv)}^2 \text{ at } ③}{\text{Base 3-}\phi \text{ kva}}$

BASE VALUES of kva, voltage, current and impedance are derived from **kva** base common throughout system. V_b, I_b and Z_b differ in each of voltage transformation areas

Two ways to figure s-c current

Calculating the short-circuit current that would exist if a fault were to occur in a complicated distribution system is not as tough a job as it might seem. Proceeding step by step, percent-impedance or per-unit method reduces system to a single short-circuit value. A second, simpler, method can be used where resistance need not be considered. This is the short-circuit-kva method, p 102. Direct application of Ohm's law won't be considered because it is awkward and lengthy.

Percent impedance method depends on conventional rating of equipment in percent impedance or per unit (pu), which is percentage divided by 100. (It's advisable to convert % to pu before calculating.) Percent impedance ratings have advantage that they're the same on both sides of transformer winding. Common reference is established by proportion: kva times percent impedance (%X). Doubling kva doubles %X; reducing kva by one-third reduces %X by the same amount. For short-circuit conditions, percent impedance can be interpreted as percent of rated voltage required to circulate rated current when machine (static or rotating) terminals are shorted. A 10% impedance means it takes 10% of rated voltage to get rated current. Conversely, 100% rated voltage (10 times 10%) will circulate 10 times rated current.

Since current is proportional to mva, 10 mva with 20% is the same as 5 mva with 10%. This is true, of course, only for short circuits.

Actual values are found by multiplying pu by a base value. Base values for different areas of the system are shown in sketch, above. System base kva *is chosen arbitrarily;* a convenient value is rating of largest machine on system. System %X is referred to system base kva by:

$$\frac{\text{system kva} \times \text{equipment \%X}}{\text{equipment kva}}$$

Ohmic values of lines can be converted to pu values as follows:

$$\text{pu impedance} = \frac{\text{ohms}}{Z_b \text{ of area}}$$

How these principles are applied is demonstrated in example, p 100. Before finding a solution, however, we must investigate the source of energy to a fault, rotating machinery. Transformers, lines and reactors have one value of percent impedance, but rotating machines have three: *subtransient, transient* and *synchronous.* At first instant of fault the low subtransient impedance predominates. This passes into the transient impedance, which in turn becomes high synchronous impedance of steady-state condition. Because machines have this varying impedance during short-circuit conditions, two values of short-circuit current must be calculated when it is desired to determine both momentary and interrupting duty of circuit breakers.

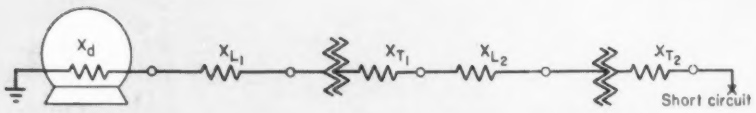
Turn page

Power to grow . . . electrically

Short-circuit current calculations are fundamental to any planned expansion of your electrical distribution system. Haphazard growth often leads to a dangerous situation where protective equipment is inadequate to interrupt short-circuit current that may occur on a fault. The Power to Grow . . . *electrically* editorial program was initiated to encourage sound planning of distribution. This article belongs in your PTG file along with the regular series on adequate system design.

Rotating machinery's contribution to fault

Transformers and lines in series with machine impedances

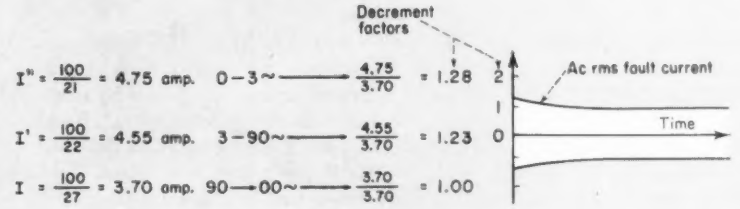


$X''_d = 1\Omega + X_{L_1} = 10\Omega + X_{T_1} = 3\Omega + X_{L_2} = 4\Omega + X_{T_2} = 3\Omega = 21\Omega$

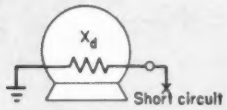
$X'_d = 2\Omega + X_{L_1} = 10\Omega + X_{T_1} = 3\Omega + X_{L_2} = 4\Omega + X_{T_2} = 3\Omega = 22\Omega$

$X_d = 7\Omega + X_{L_1} = 10\Omega + X_{T_1} = 3\Omega + X_{L_2} = 4\Omega + X_{T_2} = 3\Omega = 27\Omega$

Small varying magnitude — Large fixed magnitude — Resultant magnitude


Decrement factors
$I'' = \frac{100}{21} = 4.75$ amp. 0–3~ $\frac{4.75}{3.70} = 1.28$
$I' = \frac{100}{22} = 4.55$ amp. 3–90~ $\frac{4.55}{3.70} = 1.23$
$I = \frac{100}{27} = 3.70$ amp. 90–00~ $\frac{3.70}{3.70} = 1.00$
2
1
0
Ac rms fault current
Time

Machine impedance only

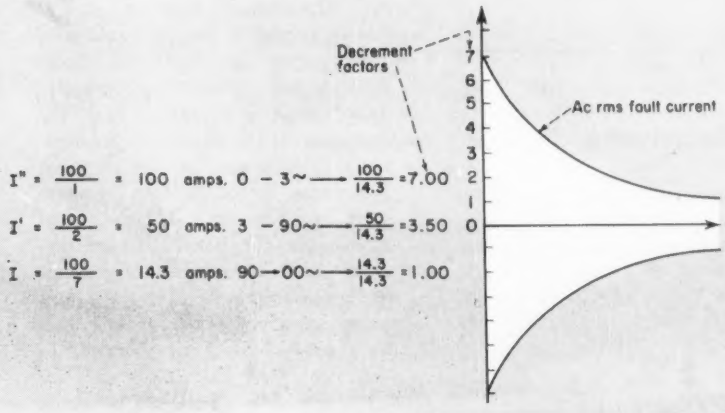


$X''_d = 1\Omega = 1\Omega$

$X'_d = 2\Omega = 2\Omega$

$X_d = 7\Omega = 7\Omega$

Small varying magnitude — Resultant magnitude



Fault remote from rotating machine

In general a large fixed magnitude in series with a small varying magnitude yields a resultant value nearly constant in magnitude. This is why a transformer out on a line can be represented as an impedance behind one available short-circuit kva. A utility source behind a transformer can usually be considered as one value for both momentary and interrupting duty of circuit breakers. Notice that a 7-to-1 variation in machine impedance between initiation of fault and steady-state condition results in only a 1.28-to-1.00 variation in system impedance viewed from the fault.

Fault close to rotating machine

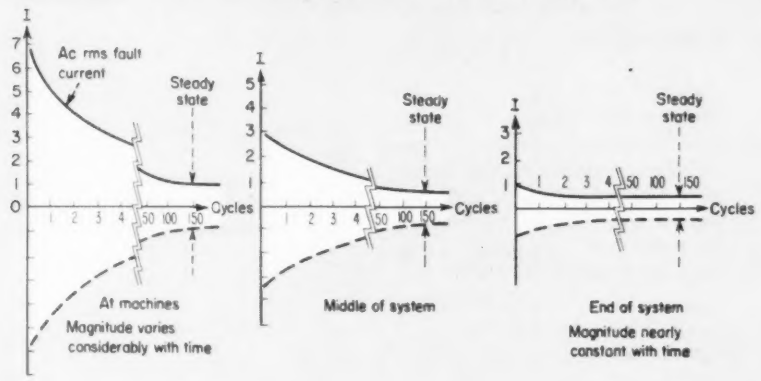
When fault occurs close to rotating machine, as in case of in-plant generator, magnitude of resultant short-circuit impedance is same as varying impedance of machine. Initial fault current in example is seven times steady-state value. X''_d represents substransient impedance; X'_d is transient impedance; X_d is steady-state impedance.

current depends on its location in circuit

Location of fault in the system

Examples, p 98, show that varying characteristics of rotating machine impedances are of utmost importance when the fault is at the machine's terminals, but of little importance when the fault is remote. Rule applies to symmetrical and asymmetrical transient.

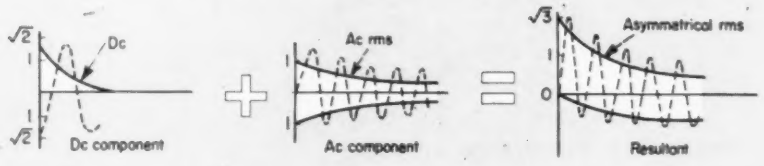
Fault location determines size of symmetrical transient



Asymmetry

Asymmetrical effect of switching depends on point of cycle at which interruption occurs and on power factor of system. Initial offset will have a magnitude from 0 to $\sqrt{2}$ times the symmetrical rms current. Relationship between ac (symmetrical) and dc (offet) components is: Asymmetrical rms current $= \sqrt{I^2_{dc} + I^2_{ac}} = \sqrt{(\sqrt{2})^2 + (1)^2} = \sqrt{3} = 1.73$.

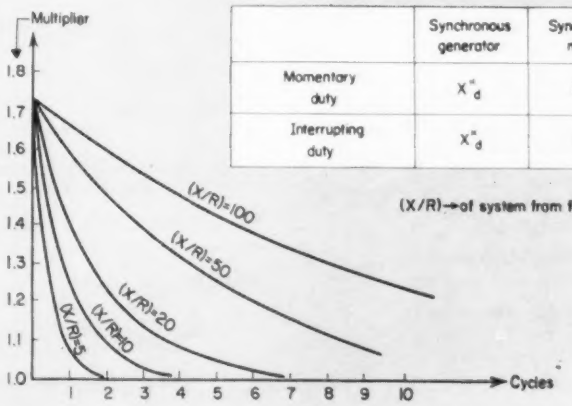
Fault current may be asymmetrical



Determining asymmetrical current

A multiplier to convert symmetrical to asymmetrical current based on circuit conditions gives more realistic results than maximum figure of 1.73. Graph takes into consideration the ratio of reactance to resistance. Accompanying chart summarizes rotating machine behavior to be considered in figuring ac component. Quick-reference table gives typical multipliers.

Asymmetrical current calculation



	Synchronous generator	Synchronous motor	Synchronous motor
Momentary duty	X''_d	X''_d	X''_d
Interrupting duty	X''_d	X'_d	∞

(X/R)→of system from fault

Device		Interrupting duty		Momentary duty	
		Remote Generator	At Generator	Remote Generator 5000 v or less	At Generator
Power circuit breaker:	8-cycle	1.0	1.1	1.4	1.6
	5-cycle	1.1	1.2	1.4	1.6
	3-cycle	1.2	1.3	1.4	1.6
	2-cycle	1.4	1.5	1.4	1.6
Air circuit breaker, 600v or less		1.25		1.25	
Power fuses		1.6			

Let's find available short-circuit current

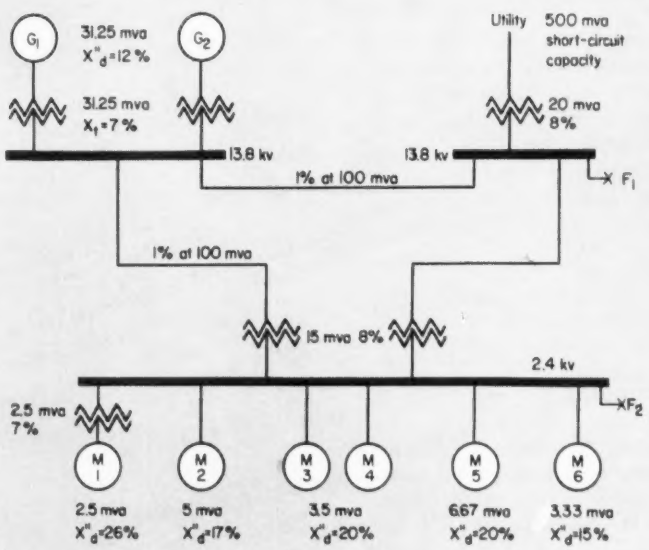
Calculations

Required steps are: (1) one-line diagram (2) convert all percentages to common system kva base (3) reduce system to one impedance (4) solve symmetrical fault capacity (5) apply appropriate multiplier to determine asymmetrical fault capacity.

Impedance conversion to kva base

Consider each area of system in turn. Find new percent impedance in terms of mva base that corresponds to rated percent impedance and mva of equipment. (Mva is used instead of kva because of size of system in example.) Subtransient impedance X''_d is used for rotating machines. Utility source is assumed to have a constant short-circuit capacity of 500 mva. Note that although per-phase quantities are the basis for pu system, line-to-line voltage and 3-phase mva can be used because the $(\sqrt{3})^2$ factor in the voltage cancels the 3 in the mva term.

Step 1. One-line diagram



Step 2. Convert impedance to common 20-mva base

Generation

$0.12 = X''_d$

$0.07 = X_1$

$0.19 = (X''_d + X_1)$ on 31.25 mva

$$X_{new} = \frac{Mva_{new}}{Mva_{old}} \times X_{old} = \frac{20}{31.25} \times 0.19 = 0.1216$$

Utility source

$$= \frac{20}{500} \times 1.0 = 0.04$$

Note: Factor 1.0 is used because it takes 100% voltage to circulate 500 short-circuit mva

Motors

$$M_6 = \frac{20}{3.33} \times 0.15 = 0.90 \qquad M_5 = \frac{20}{6.67} \times 0.20 = 0.60$$

$$M_3 + M_4 = \frac{20}{(3.5+3.5)} \times 0.20 = 0.57 \qquad M_2 = \frac{20}{5} \times 0.17 = 0.68$$

$$M_1 = \frac{20}{2.5} \times (0.07 + 0.26) = 2.64$$

Lines

$$= \frac{20}{100} \times 0.01 = 0.002$$

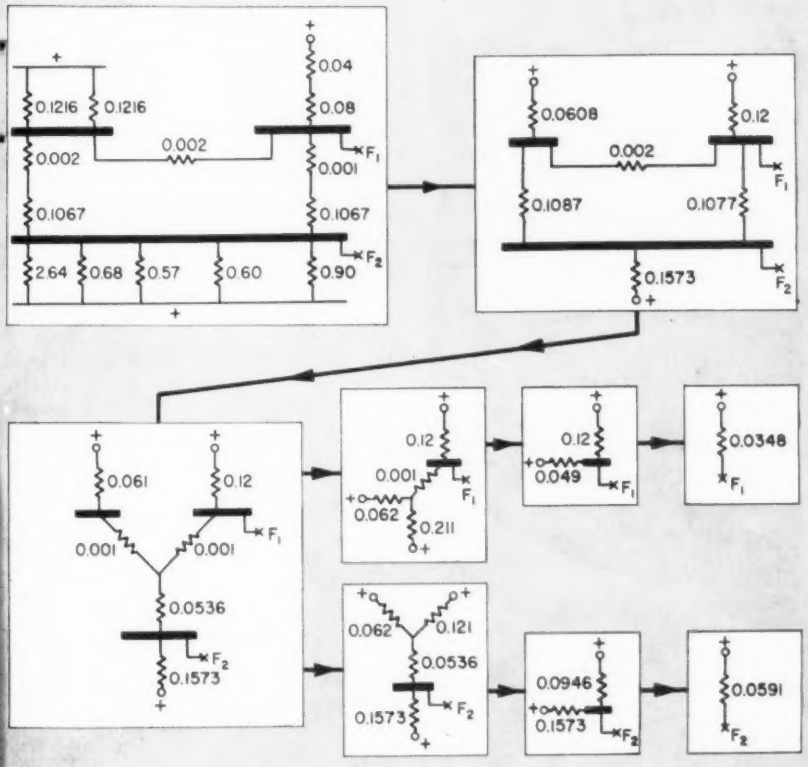
$$puX = \frac{X_{act}}{X_{base}} = \frac{0.0095}{(KV_b{}^2/Mva)} = \frac{0.0095}{\left[(13.8)^2\ K^2/20M\right]} = 0.001$$

Tie-line transformers

$$= \frac{20}{15} \times 0.08 = 0.1067$$

# of a typical industrial distribution system

Step 3. Reduce to one impedance



Step 4. Solve symmetrical fault

F_1

$0.0348 \rightarrow \text{pul} = \frac{1.0}{0.0348} = 28.7;\ I_{amp} = \text{pul} \times I_{base} = 28.7\left(\frac{20 \times 10^6}{\sqrt{3} \times 13{,}800}\right) = \underline{24{,}000 \text{ amp sym}}$

(or) Short-circuit mva $= \frac{20 \text{ base mva}}{0.0348} = \underline{574 \text{ mva sym}}$

F_2

$0.0591 \rightarrow \text{pul} = \frac{1.0}{0.0591} = 16.9;\ I_{amp} = \text{pul} \times I_{base} = 16.9\left(\frac{20 \times 10^6}{\sqrt{3} \times 2400}\right) = \underline{81{,}250 \text{ amp sym}}$

(or) Short-circuit mva $= \frac{20 \text{ base mva}}{0.0591} = \underline{338 \text{ mva sym}}$

Step 5. Apply asymmetrical multiplier

F_1: momentary duty — asymmetrical multiplier

24,000 amp sym × 1.6 = 38,400 amp asym

574 mva sym × 1.6 = 916 short-circuit mva asym

F_2: momentary duty — asymmetrical multiplier

81,250 amp sym × 1.6 = 130,000 amp asym

338 mva sym × 1.6 = 540 short-circuit mva asym

Reduce to one impedance

Replace equipment in one-line diagram with pu impedances referred to base mva. Show fault locations for which you are solving (F_1 and F_2). Combine series and parallel pu impedances. Resultant diagram is a delta with single impedance at each corner. Note locations of F_1, F_2. Convert delta to wye. Simplify wye separately for each fault until you have a single pu impedance at F_1 and F_2.

Find symmetrical values of faults

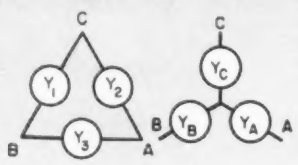
Calculate short-circuit amperes and mva at each fault by applying the pu impedance to the base mva in appropriate formulas.

Determine the asymmetrical values

Select proper multiplier (p 99) and apply it to the symmetrical short-circuit amperes and mva.

Short-circuit-kva method gives fast solution

Wye-delta conversion of short-circuit kva

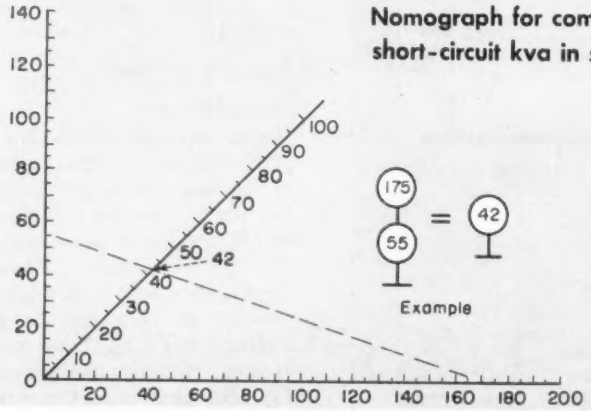


$$Y_A = \frac{Y_1 Y_2 + Y_2 Y_3 + Y_3 Y_1}{Y_1} = \frac{\Delta}{Y_1} \qquad Y_B = \frac{\Delta}{Y_2} \qquad Y_C = \frac{\Delta}{Y_3}$$

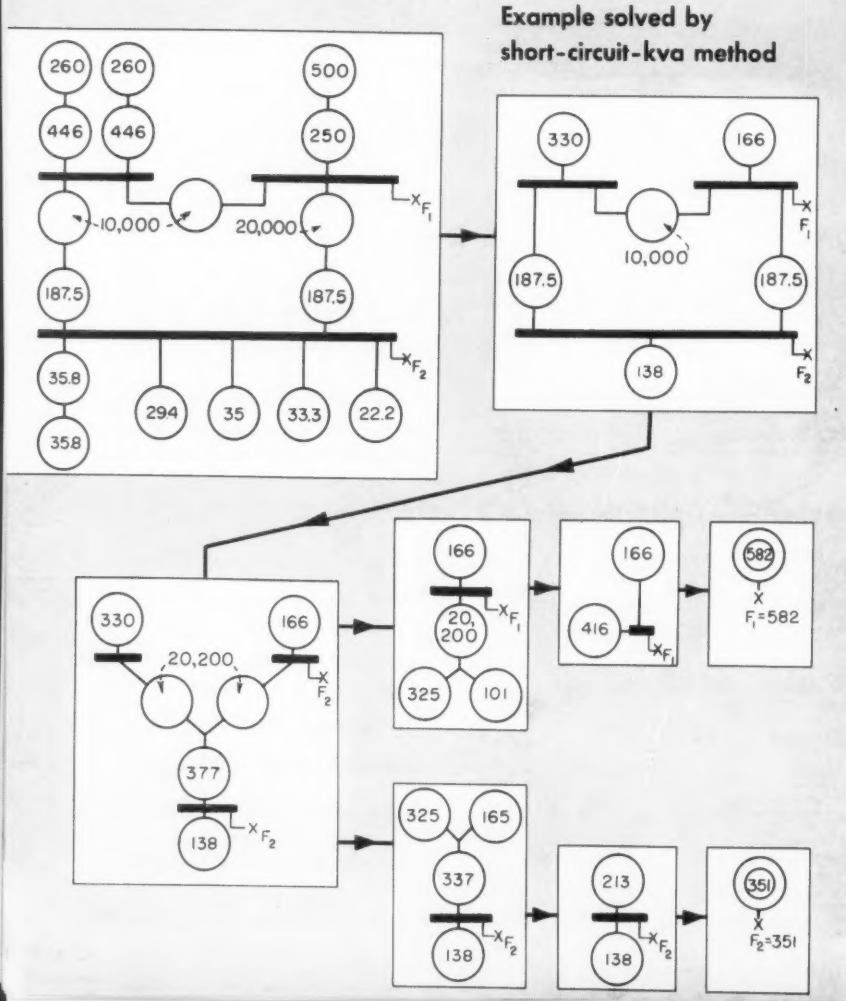
$$(Y) = \text{admittance} = \frac{1}{Z}$$

$$Y_1 = \frac{Y_B Y_C}{Y_A + Y_B + Y_C} = \frac{Y_B Y_C}{K} \qquad Y_2 = \frac{Y_A Y_C}{K} \qquad Y_3 = \frac{Y_A Y_B}{K}$$

Nomograph for combining short-circuit kva in series



Example solved by short-circuit-kva method



Convert equipment

Rated percent impedance and kva are changed directly to short-circuit kva by formulas, below. Values in parallel are added directly; those in series are combined like impedances in parallel. Wye-delta conversions are accomplished using short-circuit kva and formulas in diagram.

Handy nomograph

Rapidly combine series short-circuit values with this device. Scales can be easily extended for larger kva by multiples of 10, 100, etc.

Solution of example

Take the same system we solved by percent-impedance method, starting with one-line diagram, p 100.

Step 1. Convert rated kva into short-circuit kva:

$$\text{short-circuit kva} = \frac{\text{rated kva}}{\text{pu impedance}}$$

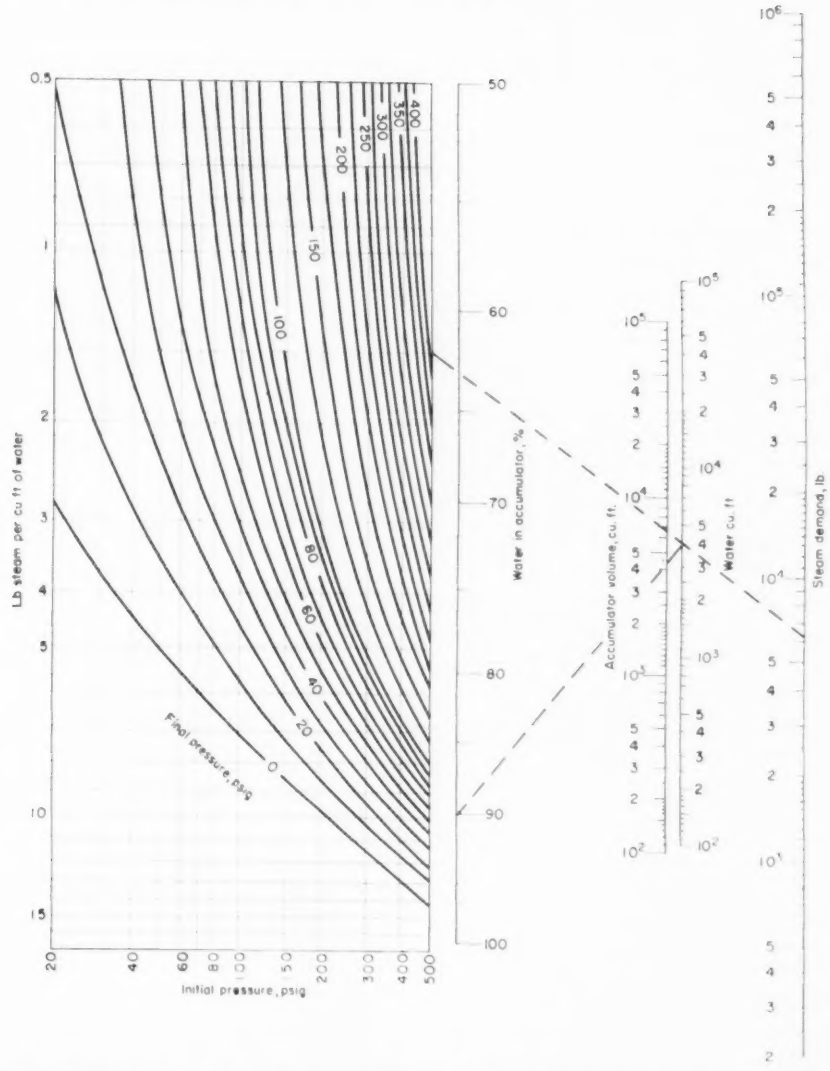
$$= \frac{(\text{line-to-line kv})^2}{\text{ohms}}$$

Step 2. Successively combine the short-circuit kva of the system until it is represented by a single value at each fault, F_1 and F_2.

Perforated for your filing ease

Power's data sheet

No. 305



Accumulator volume needed to generate peaking steam

Steam accumulators work with boilers to supply short-time high-peak demands. Boiler steam heats accumulator water at normal line pressure at same time it feeds normal process loads. When load peaks, steam pressure drops. This lets some accumulator water flash to steam and supply bulk of demand increase. When demand drops to normal, line pressure rises and boiler steam reheats accumulator water in readiness for the next steam peak to follow.

Accumulators must be sized to peak load and pressure drop expected. Here's how chart, above, helps do this:

Example: A steam demand occasionally needs an additional 6250 lb for short periods. Normal line pressure of 180 psig drops to 130 psig during peaks. How much volume must the accumulator have when it is kept 0.9 full of water?

Enter graph at 130 psig, follow up to 130 psig curve. Go horizontally to right edge—from here lay straightedge to 6250 lb *steam demand* on scale, right. Find intersection with *water, cu ft* scale to read 4000. From here lay straightedge to 90 on water in *accumulator*, %. Read answer of 4400 cu ft on *accumulator volume* scale, second from left.

B J Reitzer, *Chicago, Ill.*
W C Gates, *Wheeling, Ill.*

© POWER

A NEW CONCEPT IN FURNACE DESIGN

for Multiple Firing of Gas, Oil and a Wide Range of Coals

When multiple fuels are to be burned in a steam generating unit, one of the problems to overcome is the variation of steam temperature with the different fuels.

Design Based on Worst Coal That Can Be Anticipated

In designing and engineering a unit in which gas, oil and coal are to be burned, the amount of furnace heating surface supplied depends upon the slagging characteristics of the coal. If the coal to be used has a minimum ash softening temperature of 2100 F., in order to avoid objectionable slagging, the unit must be designed so that the furnace exit gas temperature will be approximately 100 degrees less than the ash softening temperature, or 2000 F.

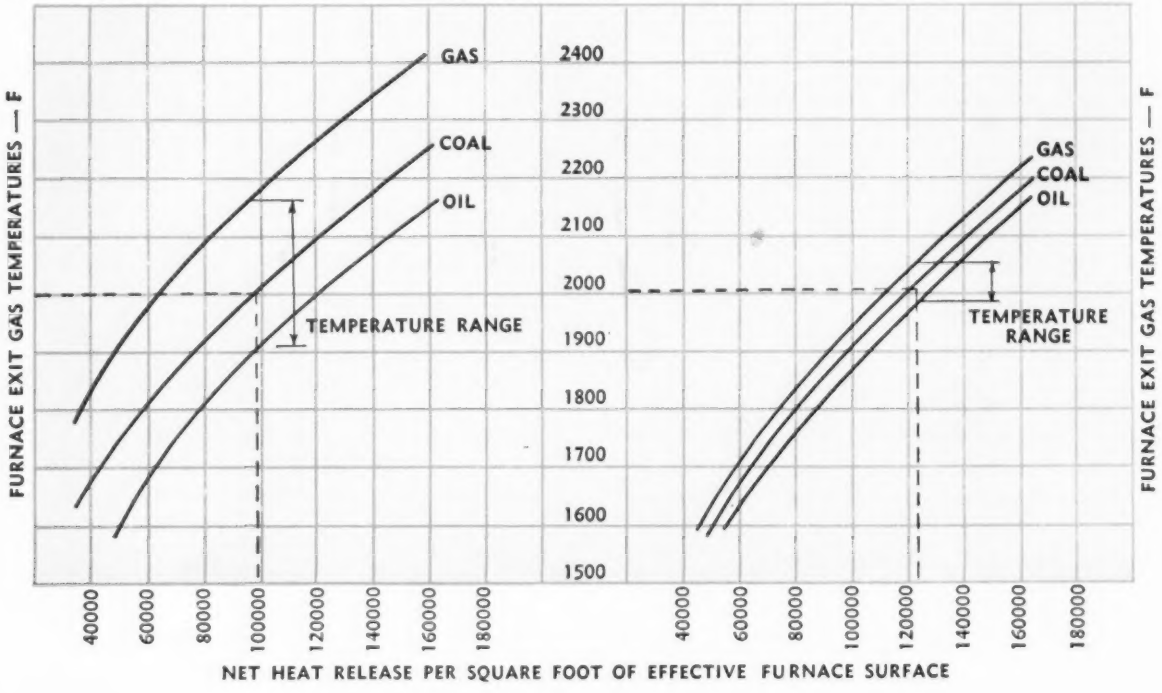
Conventional Units Need Extensive Steam Temperature Controls

When natural gas is burned in a conventional unit designed for coal with an ash softening temperature of 2100 F., the exit temperature would rise to approximately 2165 F. (Fig. 1) resulting in higher steam temperature than desired.

FURNACE TEMPERATURES

FIGURE 1 — CONVENTIONAL FIRING

FIGURE 2 — TURBO FURNACE FIRING

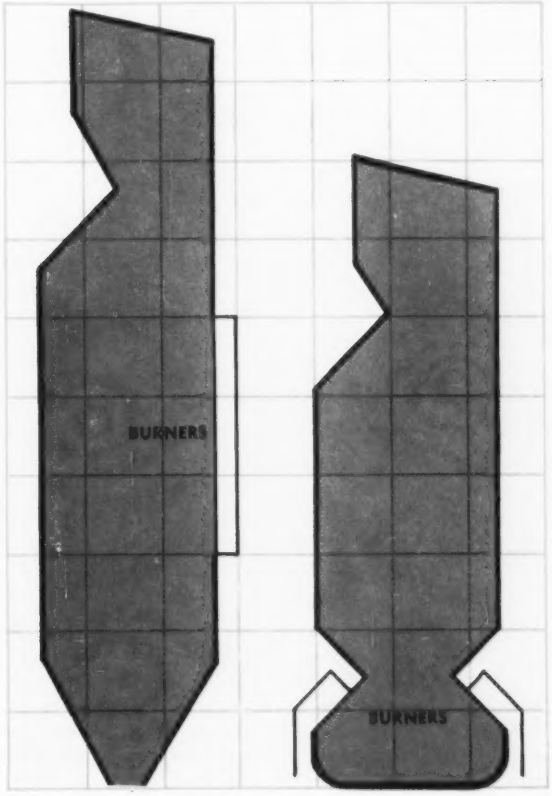


When oil is burned in a conventional unit burning this coal the exit temperature would drop to 1900 F. resulting in a lower steam temperature than desired. Extensive means to control steam temperature must be provided to overcome this variation in steam temperatures.

The Ideal Design for Multiple Fuels

The ideal design of a multiple fuel unit would be one which would produce the same furnace exit gas temperature regardless of the fuel burned. Figure (2) shows the exit gas temperature curves from a Riley Turbo Furnace unit. Note the material reduction in temperature variation with the different fuels. This relative similarity in exit temperatures reduces the problem of steam temperature control to a minimum, and makes it possible to carry approximately the same constant steam temperature range with all fuels.

FIGURE 3 – COMPARATIVE FURNACE SIZES



CONVENTIONAL FURNACE TURBO FURNACE

Uniform Furnace Exit Temperatures

Relatively uniform exit temperatures with all three fuels, when fired in a Riley Turbo Furnace unit, result from the burning of the fuels in the bottom of the unit. Combustion is substantially completed within the confines of the furnace bottom, and with this design, gas burns with a luminous flame. These operating characteristics result in a lower furnace exit temperature with a given heat release per square foot of effective radiant surface.

Overall Unit Size Reduced

To obtain a low furnace exit temperature of 2000 F. with a conventional unit, (Fig. 1), it is necessary to design the unit with a heat release of 98,000 b.t.u. per sq. ft. of effective heating surface. With a Riley Turbo Furnace unit, to obtain this same furnace exit temperature, this furnace heat release would be 122,000 b.t.u. (Fig. 2). This results in an appreciably lower unit, see Fig. (3), another of the many advantages of the Riley Turbo Furnace.

Clean Heating Surfaces

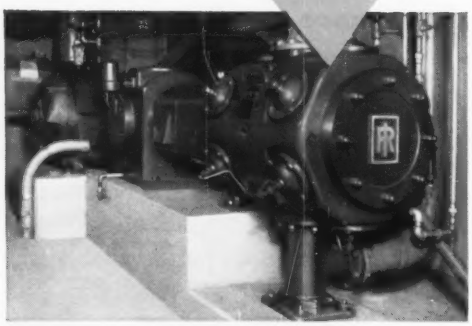
A relatively high temperature is obtained in the Turbo Furnace bottom resulting in rapid and complete combustion. The burners, arranged for opposed firing, produce a uniform distribution of heat without the intense heat zones at the core of the flames that occur with conventional burners. There is no impingement of flame or slag on furnace walls. Heating surfaces stay clean.

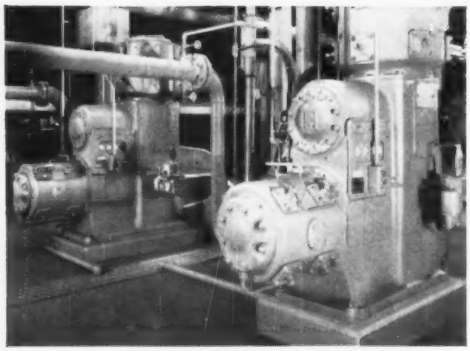
A Riley engineer will gladly give you complete information about this latest Riley development. Write — Boiler Engineering; Riley Stoker Corporation, Worcester, Massachusetts.

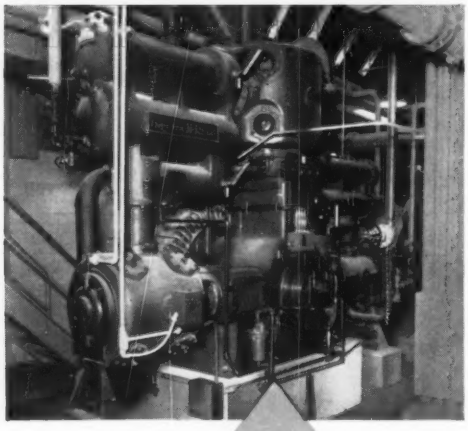
RILEY
STEAM GENERATING & FUEL BURNING EQUIPMENT

THE RIGHT COMPRESSOR

for EVERY Power Plant application







Compressors designed
FOR THE JOB operate
most dependably and economically

for INSTRUMENT AIR
ESH-NL Compressors 20 to 150 hp

Ingersoll-Rand heavy-duty Class ESH compressors with NL (non-lubricated) cylinders meet the most exacting instrument-air requirements—dependability, continuity of service and *oil-free air*. The NL piston is fitted with graphitic-carbon supporting and pressure rings, requiring no oil, grease, water or glycerine for lubrication.

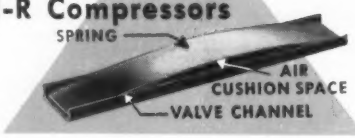
for GENERAL SERVICE AIR
XLE Compressors 125 to 350 hp

The XLE is a two-stage, electric-driven, heavy-duty compressor. The proven design, using full-floating aluminum bearings, and thru-frame air flow with packaged intercooler, makes the XLE a logical choice wherever a dependable supply of service air is required. Maintenance and operating costs are low. The machines are easy to install, requiring only a minimum of foundation because of their excellent running balance.

for SOOT BLOWING
TVH Compressors 200 to 450 hp

These three-stage compressors have been specifically developed for heavy-duty soot-blowing service at pressures from 350 to 500 psi. Inverted "T" design, with self-contained intercooling assures high overall efficiency, low discharge temperatures and smooth running balance.

Only I-R Compressors



have CHANNEL VALVES

I-R Channel Valves are known the world over for their high efficiency, remarkable durability, long service life and freedom from maintenance. On opening, the valve channel lifts upward against spring pressure—trapping a cushion of air between the channel and spring. This exclusive air-cushioned design cuts impact shocks, reduces wear and assures quiet operation.

NL Channel Valves for non-lubricated cylinders are the only valves designed specifically for this service, with no metal-to-metal sliding or rubbing surfaces, assuring sustained high efficiency and longer valve life.

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Plant maintenance and management section

STEVE ELONKA
Associate Editor in Charge

ABILITY, not seniority, is the No. 1 factor as these refinery electricians...

Train for fast promotion

By FRED LEWIS
Esso Standard Oil Co

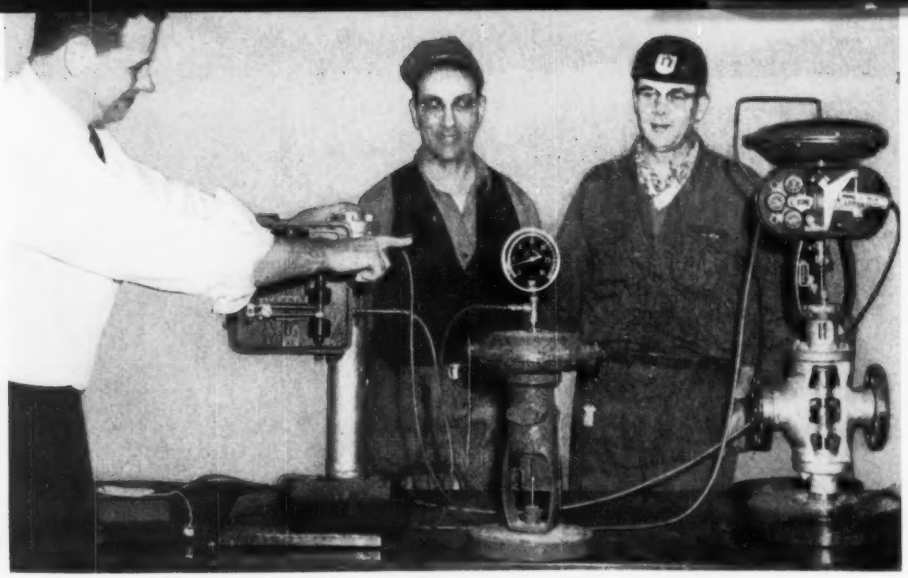
Now, lack of seniority — a career roadblock to many able young employees—is no longer a problem at Esso Standard Oil Co's Everett, Mass. refinery. Their new mechanical training program enables a man to start as a beginner and in five years to achieve a first-class mechanic's rating. For those who participate, the program replaces an older advancement plan in which a man starts as a helper, works up to third- and second-class ratings, and eventually makes first class—if someone retires or is transferred, leaving an opening in the first-class ranks.

Training is offered in all ten crafts employed at the refinery—boilermaker, weldor, carpenter, mason-insulator, painter, electrician, instrument man, machinist, pipefitter and rigger. Most of the program is practical on-the-job training and working-time classroom study. But employees who lack a basic knowledge of subjects such as mathematics or blueprint reading are offered these subjects after hours, either at the plant or in nearby schools under an educational refund system. Outside training, however, is strictly voluntary, and trainees can fill the requirements through on-the-job training and classroom work.

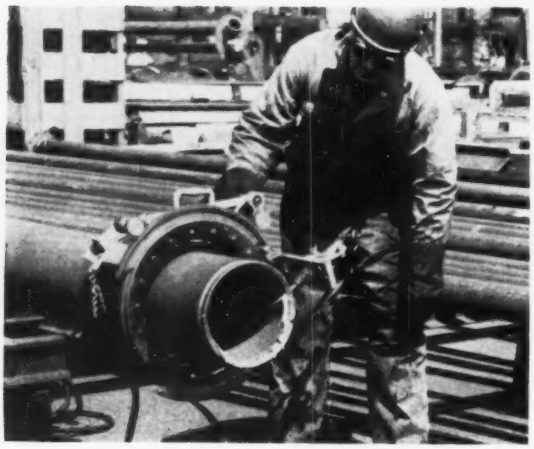
On-the-job tests are conducted during working hours to determine how individuals are progressing and to evaluate the success of the particular course.

For purposes of the program, regular plant work in each craft is divided into ten steps, in order of difficulty. Trainees are started at the step that best suits their experience, so as to work and train at their peak performance level. Reports on each trainee are reviewed monthly by the Mechanical Department. If qualified, the trainee is advanced a step every six months, both in pay and job level.

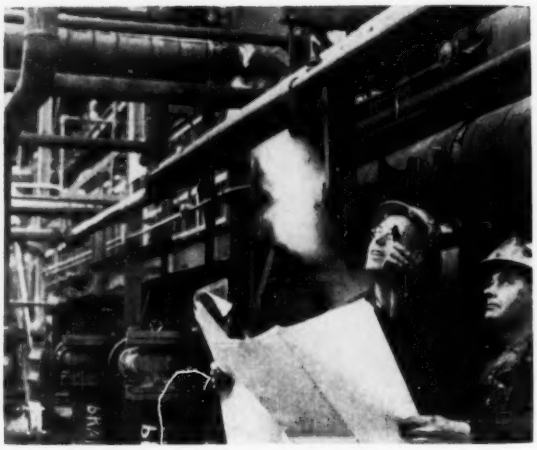
Turn page



INSTRUCTOR explains calibrations, adjustments of level controller



TRAINEE uses portable burning equipment



PIPEFITTING trainee OK's refinery piping

Advancement depends on trainee's ability and the headway he makes

Except for painters and insulators, who complete their less specialized programs in three years, all training is on a 5-yr basis. Courses for instrument man and electrician are considered the most difficult, for their work is highly specialized. Electricians, for example, must also qualify for a license issued by the State of Massachusetts.

Classroom training during working hours is conducted by plant training supervisors and manufacturers' representatives. One unique aspect of this classroom study is the discussion of plant problems that would not ordinarily come to the attention of trainees. Here, each man gets a broader view of plant operations, helping him to understand better his own work as well as the problems of others.

Each craft has its own training manual, supplied by the company. But literature prepared by the manufacturers of refinery equipment is also used for instructional purposes. No written homework is given for on-the-job training. Testing by performance and oral questioning is used to evaluate individual progress and success of the courses. There's also a 3-hr 7-part test covering many things from general knowledge to mechanical aptitude that's given to men "bidding in" for a job in a par-

PROCESS OPERATOR checks intricate emergency system

SESSION of Joint Mechanical Trades Advisory Committee discusses problems, progress

in the very practical courses given at this progressive refinery

ticular craft. Poor test performance in voluntary after-hours courses does not disqualify a man from continuing in the program. Eventually he can achieve a first-class rating.

Overall direction of the program, which was a year old last August, is the responsibility of the refinery's mechanical superintendent. A 5-man advisory committee, composed of the plant's training supervisor, two management representatives and two members of the Everett Refinery Independent Union, reviews the progress of the trainees and the program itself. They also recommend ways to improve the program.

Program was developed by union and management together—both are happy with it. At present, 68% of the plant's eligible employees are participating, and 16 first-class mechanics have been "graduated" in the first year. Only one man has dropped out of the program since it started last year.

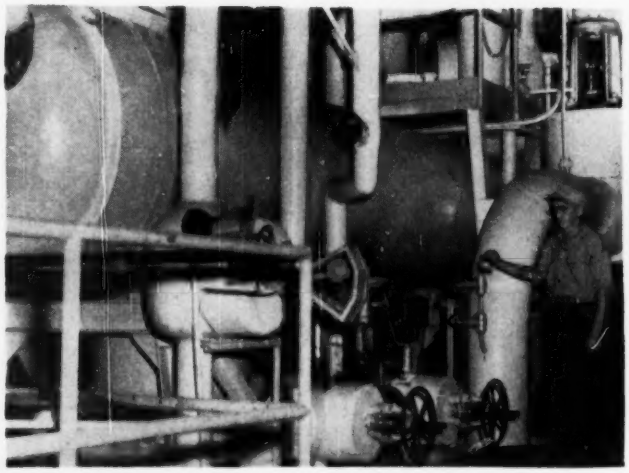
Although length of service retains its importance in other matters, it no longer keeps the short-term employee from performing first-class work—at first-class pay.

ED. NOTE: *This is one in a series of articles on training. Because equipment is getting to be so highly specialized and complicated, more industries are going in for training programs.*

OPERATORS' NOTEBOOK 115

Right rods, materials,

This high-pressure feedwater heater was ready to be scrapped until someone came up with the right repair technique



FEEDWATER EXTRACTION HEATER leakage didn't stop after previous repairs. Right rod and procedure solved the problem

WELDING TUBING ENDS through this channel was a tough job

The 1800-psi feedwater extraction heater of a West Coast power plant started leaking through the tube sheet shortly after it was installed. Unit has 2-passes, a 3⅜-in.-thick forged-carbon-steel tube sheet, 570 ¾-in. 70-30 cupro-nickel tubes of 0.070-in. wall thickness, and is 48 in. in diameter. Tubes are on a 1-in. triangular pitch. Leaks became so bad that the heater had to be cut out of service for a complete retubing job.

Repair job. Retubing failed to stop the leaking. Feedwater leaked excessively from the tube bundle into the drip system, so the heater was again taken out of service. This time the straight tubes were replaced with floating head and U tube bundle.

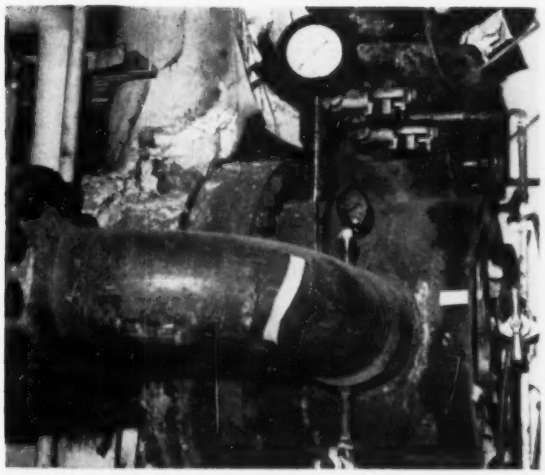
Retubed heater was cut back into service, but within several days leaked again. Three weeks later the unit had to be removed from service. Then started a long series of experimental tests on methods of weld repair, using the discarded floating head that had been removed in the redesign. Since it looked like the heater couldn't be repaired by welding, prices were obtained on a new extraction heater.

But the plant super and plant mechanical engineer wouldn't give up. They believed proper welding or brazing techniques and materials would solve the problem, save the high cost of a new heater and give immediate relief to No. 1 unit boiler. Boiler suffered from lowered feedwater temperature and resulting high superheated steam temperature. Rate of load pickup and evaporation capacity was also limited.

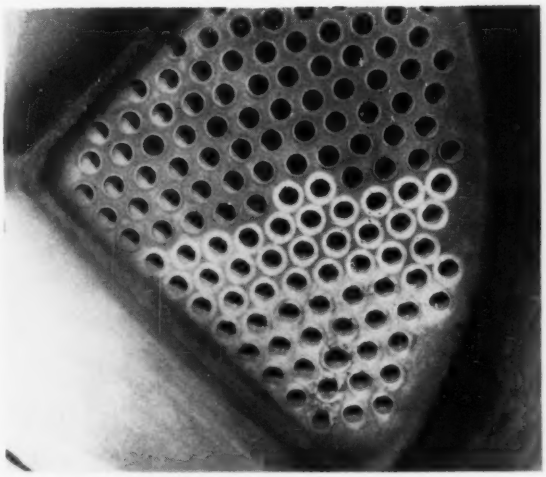
Research program. Super and engineer started by checking new materials and methods. They learned that similar repairs had been made by other utilities, but

welding technique saved heater

By STEVE ELONKA, Associate Editor



CHANNEL DEPTH through which weldor had to work is shown after insulation was removed. Tubes were reamed and welded



TOP ROWS OF TUBES are welded, center section is machined, lower section is shown as left after last attempt to repair it

could not get the actual details needed for this job.

Problem was made tougher because welding was necessary and heater couldn't be removed or its position changed because of the building's construction.

Tests. A number of small 9 x 9 x 2-in. tube sheets were fabricated to test the efficiency of the welded and brazed joints of varying sections and design. These included grooves of different depth and degree. After welding, tube sheets and tubes were cut into longitudinal sections, ground and examined carefully for penetration and weld defects. Numerous types of electrodes and brazing alloys, including some "so-called" special eutectic types, were used.

Methods for cleaning the tube and tube sheets were investigated. These included shotblast, sandblast, scraping, brushing and machining techniques.

How job was done. Research ended when very good joints were obtained. Tube sheet around outside of each tube had to be cleaned because previous welding had messed up the sheet. A special end mill was made with a pilot to fit into each tube. This tool cut a ⅛-in. wide groove around each tube into the tube sheet to a depth of 1/16 in. It also took a few thousandths of an inch off the outside of each tube. The 1/16-in. deep groove allowed for proper bonding depth of weld.

Bonding depth was important because of difference in composition and heat conductivity between the carbon-steel tube sheet and the 70-30 cupro-nickel tubes.

Although other rods and methods were tried, 90% of the completed weld repair was done with 3/32-in. 140-monel welding rods. A 60-amp weld current did the best job. When job was finished, we had a new heater.

Cause of failure. When the actual welding began, large quantities of oil exuded from between the tubes and the tube sheet, making it impossible to obtain sound welds. This showed that the holes on the tubes and tube sheets were heavily coated with oil during the rolling operation. This probably accounted for the failure of the retubing job.

When welding was finished, heater's steam side was cut back into service to heat the tube sheet and drive out the oil. After heating tube sheets for a weekend, it looked like the oil had been driven out. Tube-sheet face had also dried up. There was evidence that large quantities of oil had been removed. Then tube ends and sheet were wire brushed and welded.

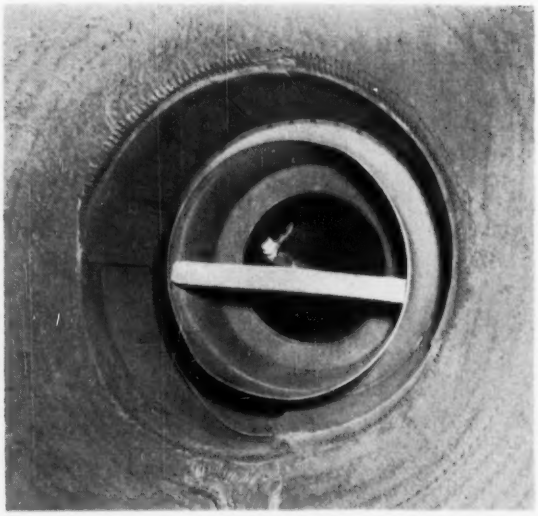
Inspection. The welds were inspected by both dye-penetrant and hydrostatic methods. Several leaks were detected and repaired. This process was continued over several cycles. A few leaks, from flux inclusions, were found and rewelded.

Heater was put back in service for a 3-week trial, then taken out of service for a final inspection. A close check showed the heater was in good shape.

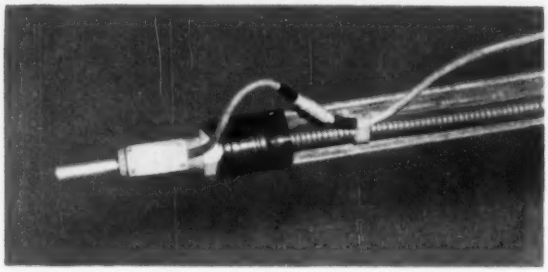
Leak-detection system. Heater was restored to service. Then a recording leak-detection system, using existing recording equipment, was hooked up. This system operates by the differential in electrical conductivity between extraction steam condensate from heater and electrical conductivity of feedwater passing through the heater. Increase in conductivity on the steam side means a leak has developed.

Results. After five years of service, not one leak has shown up.—*Courtesy, International Nickel Co, Inc*

ISOTOPE holder positioned at cyclone furnace mouth. Radioactive "pill" is in the container near man holding doserate meter



POSITIONED to traverse the longitudinal center line of the furnace, isotope is now in holder and ready to make first exposure



CABLE, isotope holder are taped to length of angle iron. Isotope travels through cable to exposure point, then is retracted

Radiographic inspection: A practical method for . . .

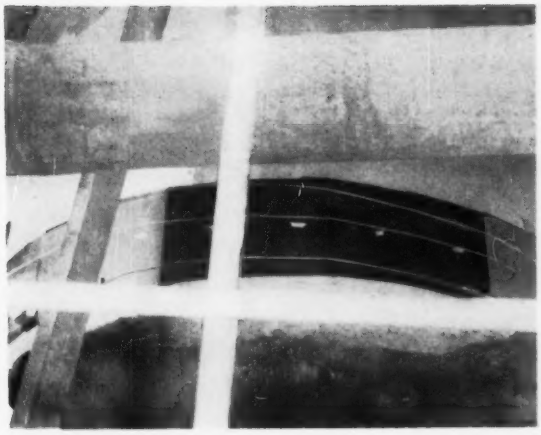
Pinpointing boiler-tube corrosion

By R M PETERSON
Magnaflux Corporation

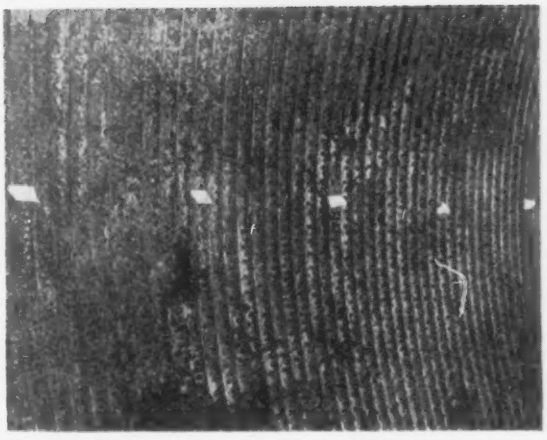
Boiler tube corrosion—long an unpredictable thorn in the power plant operator's side—is being forced out of hiding by a little pill. Though not of the "after-each-meal" variety, the pill has real potency in preventing forced shutdowns. An encapsulated radioactive isotope, it takes pictures of the tube's innards, immediately pinpoints corrosion areas.

There's nothing new about inspecting objects via radiography. For over a half-century, technicians have interposed objects between a radiation source and a film. Produced on the film is a permanent shadow image of the object in terms of its radiation absorption differential. From then on it's simply a matter of examining the film to see if everything that should be, or anything that shouldn't be part of the object is there. Knowing how to "shoot" the object and how to interpret the shadows on the film are mighty important factors.

While radiography in general



RADIOGRAPHIC FILM wrapped around circumference of furnace records tube image through casing steel and insulation



IDENTIFICATION MARKERS in cyclone furnace interior will show up on film, provide permanent record of corrosion location

isn't new, its application to boiler-tube inspection is. How successfully the technique can reveal tube corrosion was demonstrated recently at the Jersey Central Power & Light Co's Sayreville station. As part of a scheduled preventive-maintenance program, they asked us to determine location and extent of any possible corrosion in their cyclone-furnace tubes.

First step was to examine the patient. It's a relatively simple matter to radiograph an object when it can be set up to conform to limitations of fixed-position X-ray equipment. But with a boiler, the technique must be tailored to the job. And we'd have to shoot through boiler casing, insulation, etc, to get the tubes. Shadow images, however faint, of substances other than tube material would have to be thoroughly interpreted.

In our lab, we built a test section consisting of (1) boiler tubes having $\frac{5}{8}$-in. wall thickness (2) a $\frac{1}{4}$-in. steel plate, representing the boiler casing (3) a $2\frac{1}{2}$-in.-thick strip of asbestos insulation (4) a layer of chicken wire and (5) another $2\frac{1}{2}$-in. asbestos strip. Thus, by duplicating field conditions, we'd get the same pictures we'd have to work with at the plant. We located the tubes nearest to the radiation source and used the 40-in. focal distance that we'd use in the furnaces. To make sure film interpretation would be airtight, we took pictures of new tubes and tubes that had been removed from the boilers at earlier shutdowns. Some of these tubes were moderately corroded, others badly wasted. With upper and lower limits established, we were all set.

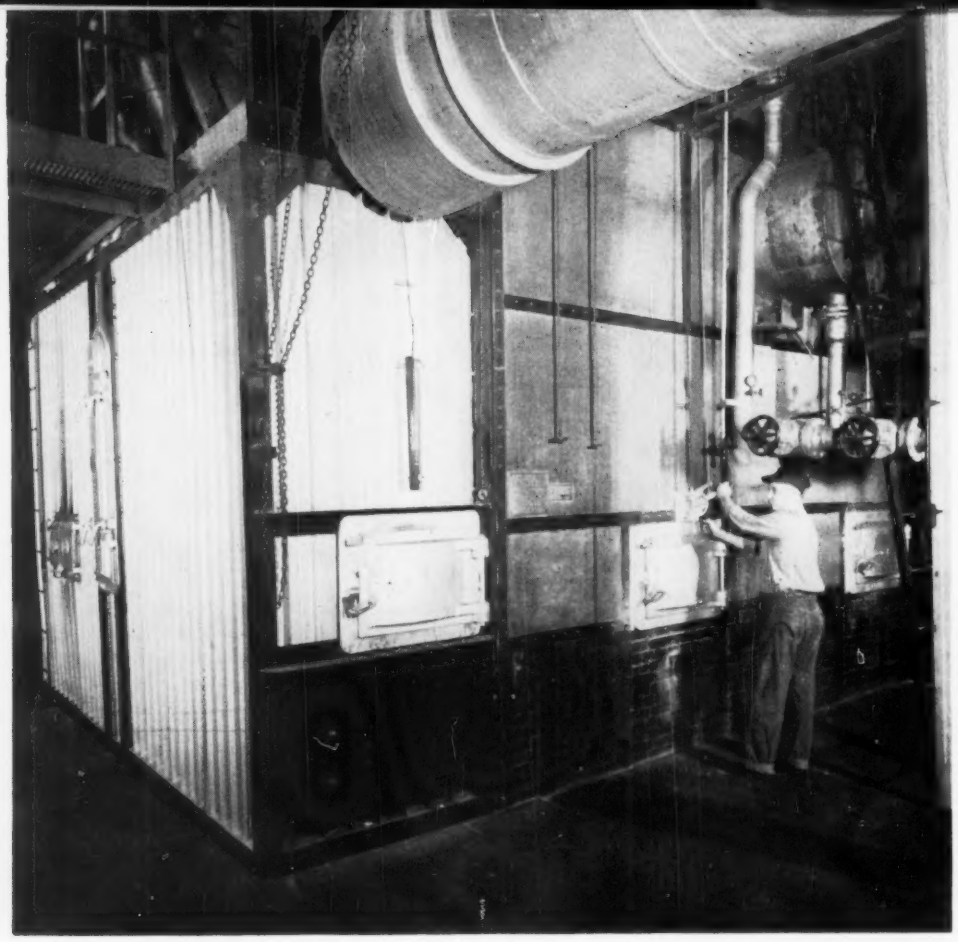
Properly positioned at the furnace mouth, photo, facing page, and with the area monitored for radiation level, the isotope holder was introduced into the furnace. Top photo, facing page, shows how the holder is held to the furnace's center line. Bottom photo shows the holder and flexible cable firmly taped to a length of angle iron. The radioactive "pill" travels through the cable from a heavily shielded container to point of exposure, then back to container.

With film wrapped around the outside, and tube identification markers placed inside, photos, above, the furnaces were completely radiographed. Working around the clock, we took 557 14x17-in. films in 43 hours.

Results were highly satisfactory. Degree of corrosion in suspected areas showed plainly on the film. Locations were reference marked on the boiler surfaces to identify which tubes should be replaced at the next regularly scheduled inspection. Other tubes, less affected, were marked for radiographic inspection again at a later date. Corrosion rate could then be determined and a decision made as to whether or not they would require replacement.

Since a boiler tube of uniform dimension will produce an even distribution of film density, any cross-sectional thickness reduction will show up on the film as an increased density area. Thus, effect of corrosion causes a change in tube-wall thickness which is readily detectable in the radiograph. However, size and shape of corroded areas visible on the film will depend on a number of factors such as: (1) focal spot or source size (2) source to object or object to film distance and (3) radiation angulation with reference to corrosion and film locations. Any of the factors could cause a defective tube area to appear enlarged or distorted in the final radiograph.

It's true that the cyclone furnace's cylindrical shape lends itself readily to radiographic inspection of the tubes. However, other tube areas, such as waterwall sections, of various boilers have been similarly inspected with the same degree of accuracy. It's no exaggeration to say that, provided the procedure can be economically justified, present inspection methods can virtually eliminate forced boiler shutdown caused by tube corrosion.



Incinerator doubles as dutch oven to...

Solve waste-wood disposal

Getting rid of up to 3500 lb per hr of waste wood posed a nagging problem for National Cash Register Co's engineers in Dayton, Ohio. From various plant buildings, some over a mile away, the waste had to be gathered and burned. In all shapes and sizes, from sawdust to boards, it meant expensive transportation, tough handling and the difficulty of burning it without smoke. The latter was especially trying because Dayton has strict air-pollution regulations, and they *enforce* them.

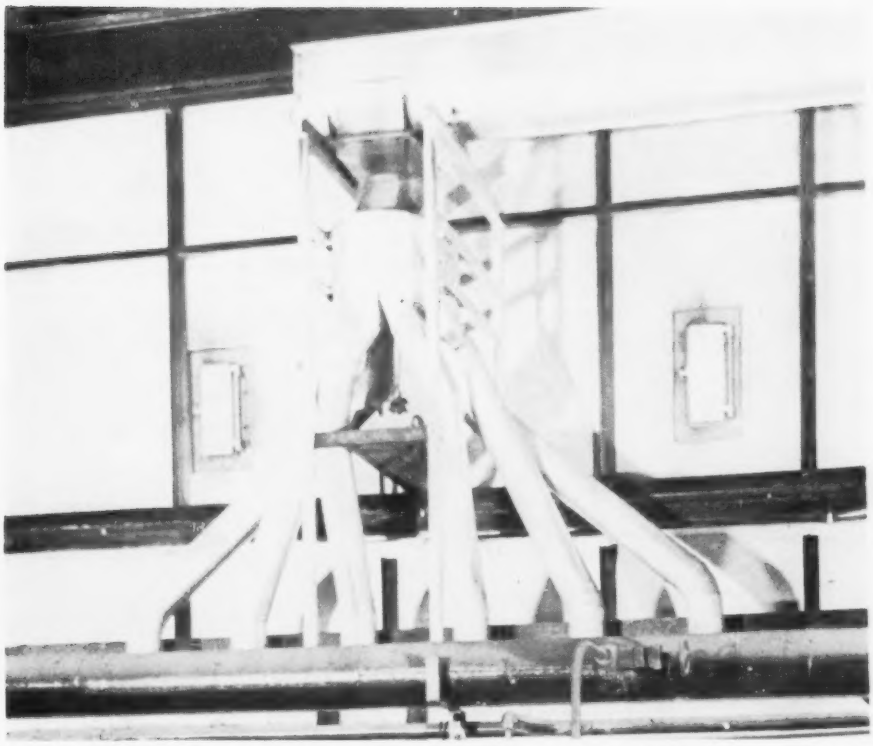
The solution was a unique combination of an incinerator and dutch oven mounted alongside a pulverized-coal burning boiler. The wall common to the oven and boiler has brickwork removed across the upper section. Heat and flames from the wood-burning oven pass through and around the boiler's exposed water-wall tubes and mingle with the furnace gases.

Scrap wood first goes through hogging machines. In small chips, it's blown from plant buildings to a cyclone chip and air separator, then drops into a storage bin. Multiple-screw conveyors across bin's bottom move chips to an open trough. Here, a larger screw feeds them to a distributor above the dutch oven.

The 4-speed bin screws are adjusted to the rate at which chips come from the plant. They empty the bin at a uniformly controlled rate to maintain constant fuel flow and firing. The larger screw in the trough is open and unconfined, prevents any explosion caused by possible flashback from the incinerator. Should a fire occur in the open trough, the primary feeder screws under the storage bin effectively seal off its contents from the flames. A long mirror above the trough allows men on floor below to see the wood moving along.

A major problem in burning wood without smoke or congestion is to get chips and shavings distributed uniformly across a grate surface. To lick this, NCR's engineers came up with a spider-like revolving-head distributor. Turning at about 90 rpm, it takes wood from the conveyor trough and successively feeds six round metal chutes leading to separate incinerator grate areas.

A forced-draft fan supplies about 6200 cfm air at 1-in. wg static pressure to a plenum chamber under the incinerator's stationary grates. Holes in the grates pass air at the right velocity to give the wood chips buoyancy and burn more than 75% of it in suspension. The wood simulates gas combustion—distilling its



REVOLVING HEAD takes wood chips from trough, sends them through spider-like distributor to chutes feeding incinerator grates

CLEAR STACK shows emission within limits of city's strict air-pollution laws, proves efficiency of incinerator-boiler hookup

and air-pollution problems

By F W REITER, Dayton, Ohio

vapors and emerging as a solid flame into the boiler furnace.

Solving wood-waste disposal without smoke was a victory in itself, but an added dividend came from fuel savings. Fortunately, NCR's waste is high-grade finishing woods such as birch and poplar. Kiln-dried to about 24% moisture, its heat content is about 6500 Btu per lb (equivalent to ½ lb coal) as compared to about 4500 Btu per lb for green woods. All in all, the potential fuel capacity of 3000 lb per hr of waste wood represents an evaporative capacity of about 16,000 lb steam per hr.

Drying (moisture evaporation) is an endothermic reaction—absorbing heat from the surrounding environment. Subsequent combustion is exothermic—producing heat. In conventional drying there's a considerable loss of available useful heat because of evaporating various percentages of moisture in the wood wastes. With the NCR unit, the combination of kiln-dried wood, wood-burning chamber and large boiler gives a heat availability of over 80%.

Successful results corroborate preliminary studies made of these recommended practices in burning hogged wood fuel:

1. In a dutch oven, radiant heat from incandescent brick walls produces gas from some hogged woods equal to about 90% of fuel's weight.

2. More gases form as water vapor in the furnace blankets the charred particles resulting from wood distillation.

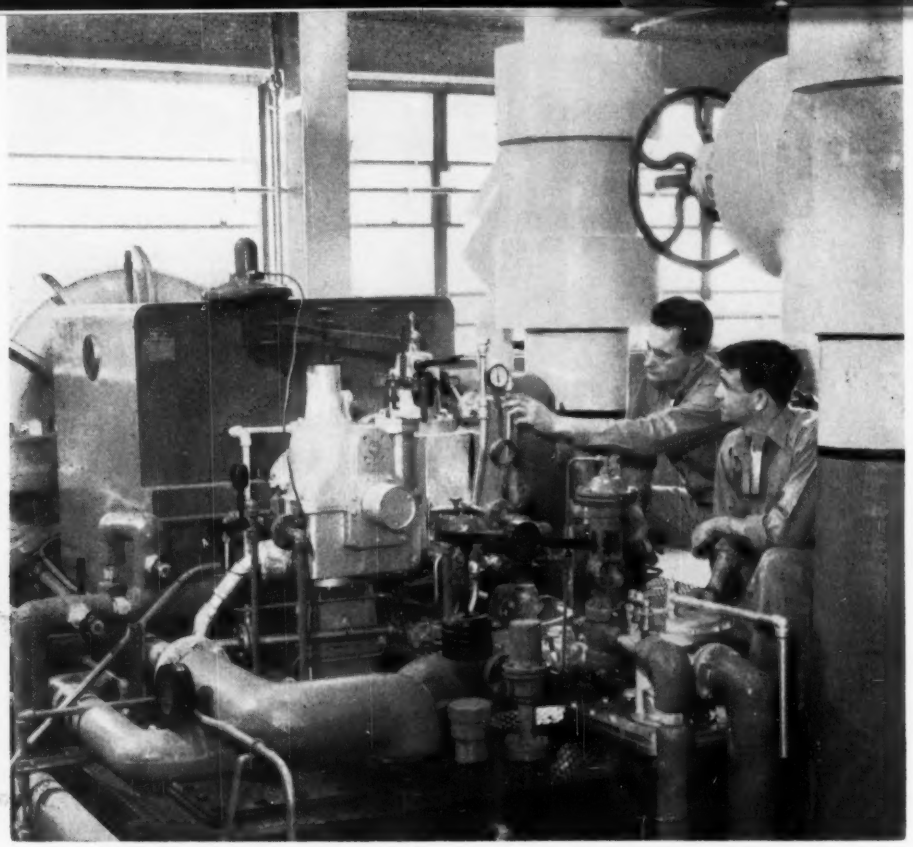
3. Endothermic reaction of the combustion process occurs in the dutch oven and exothermic reaction occurs in the boiler furnace where the heat is wanted.

4. Wood chips should fall freely from a number of openings through a relatively high oven. Particle distribution should be even throughout furnace volume to allow maximum gasification before reaching grates.

5. Avoid solid piling. Air jets, spread uniformly across the grate, should keep wood chips in suspension as long as possible.

6. Wood gases and air stratification must end on entry into boiler furnace. Here, rapid mixing should produce complete combustion. (In the NCR unit, gas passage through furnace-wall tubes produces turbulence, momentary jet-like velocities.)

The NCR unit gives ideal combustion, maximum heat utilization, no smoke and no deposits in oven or boiler furnace. It requires practically no maintenance and saves more than a carload of coal per week.



GOVERNING SYSTEM on high-speed multistage turbine (2725 hp, 6870 rpm) is under inspection. Turbine drives centrifugal compressor at this large pharmaceutical plant

Governing systems don't need an Alfred Hitchcock to make them a big mystery to many engineers. This basic explanation will help you understand . . .

By R J HALL
Turbine Specialist
General Electric Co

How mechanical drive governors work

Governing system selected for study is an oil-relayed type. Once this is fully understood, the jump to understanding multi-valve oil-relay systems is a simple one.

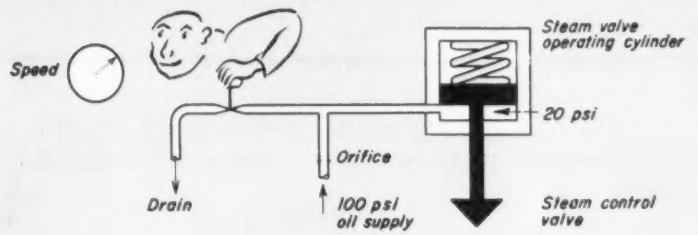
All changes in this governing system will be linear. Design problems of valve characteristics, spring constants, linkage play, dimensions, pressures, etc, will be scrupulously avoided. Assumed figures are chosen for simplicity and are not actual values applying to real systems.

Turbine speed varies with load, energy content of steam and amount of steam admitted to the turbine. If energy in the steam changes, or if load changes, the turbine steam valve must move to a new position to maintain any given speed.

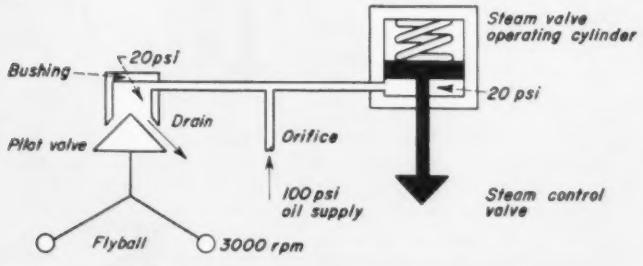
It's entirely possible for an operator to watch turbine and adjust the steam valve to maintain constant speed. He doesn't have to know the turbine load or energy content of the steam. He just moves the valve until speed is right. He'll need to practice before he's able to move the valve at the right rate of change without "hunting," "wandering" or taking too long.

Have you ever tried to steer an automobile out of a "fishtailing" motion on ice? If the rear end swings harder from side to side because of oversteering, you know what is meant by "hunting." If you've drowsed at the wheel to awake with a start with the car headed incorrectly, you know what "wandering" is. A nervous individual might move too quickly, allowing the speed to oscillate, or

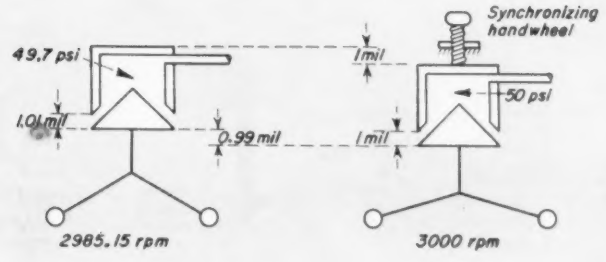
Here are the basic elements of turbine speed control



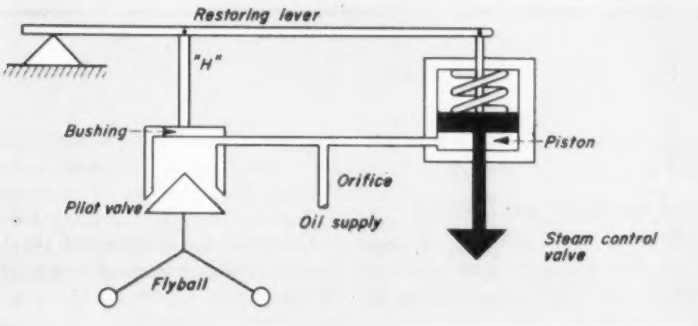
1 Operator watches gage and adjusts oil pressure. This operates turbine steam control valve to keep the speed constant



2 Flyball governor replaces both man and speed gage. It senses turbine speed and controls opening of steam control valve



3 Synchronizing handwheel on pilot valve resets governor to maintain speed at different loads or vary it at one load



4 Restoring lever lowers sensitivity or speed of response and increases speed regulation or offset of the controller

hunt. If he's lazy, he may let the speed wander.

Let's help our operator out by using an operating cylinder and piston to drive the steam-control valve with oil pressure. To bring speed back after a speed change, the man merely adjusts oil pressure on the piston shown in Figure 1.

Flyball governor

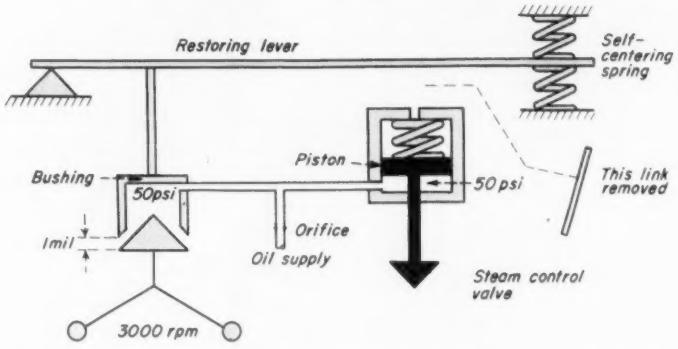
Effort expended by the operator is now reduced to the point where the man can be omitted entirely. Speed indicator is replaced by a flyball governor to sense speed and give a motion corresponding to the speed. This motion operates a pilot valve which regulates oil pressure fed to the steam-valve operating cylinder in Figure 2.

Let's assume that a full pilot-valve movement of two mils is enough to vary oil pressure on the piston from 20 psi at "no load" to 80 psi at "full load." Also assume that a 30 rpm flyball change (2970 to 3000 rpm) moves the pilot valve two mils.

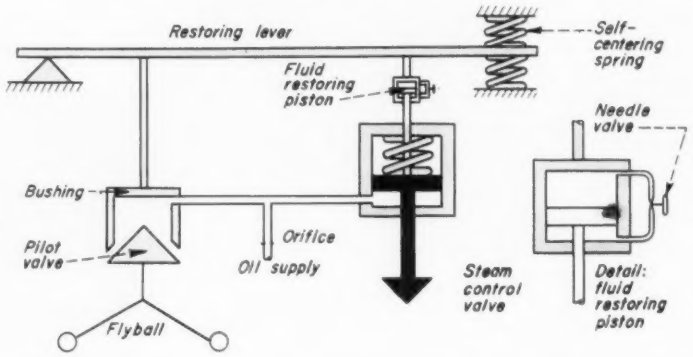
On an actual governor, the flyball is geared to the turbine shaft so that it doesn't rotate at same speed as the turbine. But to simplify our explanation we will handle governor rpm as if it were turbine rpm. Since oil pressure on the operating cylinder is related to valve position, it is a good measure of valve opening. "No load" position will be 20-psi oil; "full load" position will be 80-psi oil.

If the load in Figure 2 increases to the point where 50-psi oil is needed to maintain 3000 rpm, the speed will drop. This will raise the pilot valve

Self-centering spring and fluid-restoring piston complete the governing system



5 Self-centering spring adds a bias to restoring lever. Performance is about the same as Figures 2 (link in) and 4 (link out)



6 Fluid-restoring piston with self-centering spring produces a control system that combines the good features of Figures 2 and 4

and increase oil pressure to 50 psi. It must move one mil to raise the oil pressure to 50 psi. Flyball speed will then be 2985 rpm. But 50-psi oil will open the valve enough to carry the turbine load at 3000 rpm. So the turbine continues to speed up until a compromise is reached. This will be at about 2985 rpm, assuming that a valve movement from 20-psi to 80-psi oil causes a turbine speed change from 1500 rpm to 4500 rpm at the new load. The system will stabilize at this speed of 2985 rpm, a pilot movement of 0.99 mils, and an oil pressure of about 49.7 psi. The flyball governor cannot return the turbine to 3000 rpm at a different load, because the pilot valve supplies only one pressure, 20 psi, when the flyball is at 3000 rpm. Any other pressure calls for a different pilot-valve position.

The difference of 15 rpm between the 3000 rpm at set load and 2985 rpm at new load is called the offset, or speed droop, which affects any simple governor.

Synchronizing handwheel

If we bring our operator back into the picture and give him a handwheel on the pilot-valve bushing, he can move the bushing down at the new load. The pilot valve will then be at the 3000-rpm position of its travel and the oil pressure will be up to the 50 psi needed to drive the turbine at 3000 rpm.

This handwheel, shown in Figure 3, resets the governor to maintain speed at different loads, or to vary speed at one load. It is called the synchronizing handwheel and has the same effect as the action taken in Figure 1.

Control stability

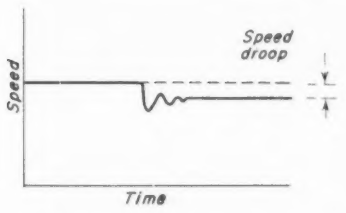
The control system in Figure 3 is not suitable for turbine governing because it is too sensitive. It is almost an "on-off" control. Speeds are recognized from 2970 to 3000 rpm, and steam-control valve passes through the full range of movement within this narrow throttling band.

Throttling band, or speed regulation, is the range of speed recognized for corrective action by the governor. Speed regulation in our example is 1.0%. It's the difference between 3000 rpm at "no load" and 2970 at "full load" divided by 3000 rpm.

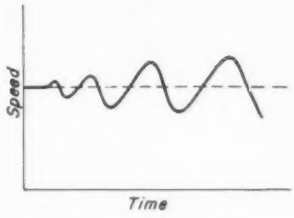
The turbine reacts so rapidly to valve change that the governor will oscillate or hunt. Turbine speed will swing above and below equilibrium, or steady state speed, because the governor calls for too much valve action too soon. In other words, this control system does not have much stability.

If a swimming pool is heated with a cigarette lighter a control system of this type will work fine because the process is insensitive (stable). High- or fixed-sensitivity controllers

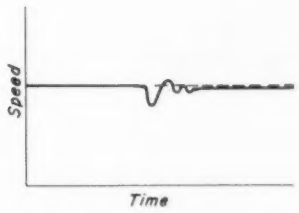
Right needle-valve setting prevents excessive hunting or speed droop



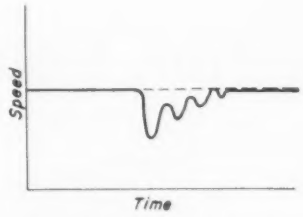
7 Closed needle valve and increased load result in this speed droop



8 Fully open needle valve is the cause of ever-widening speed oscillations



9 Needle valve set just right quickly returns speed to original set point



10 If needle valve is closed too much, speed reset time may be too long

are applicable to stable processes, low-sensitivity controllers to unstable processes.

Restoring lever

In our final control design, we will lower sensitivity, or speed of response, and increase the speed regulation, or offset.

In Figure 3 a pilot motion of only two mils opens the steam valve all the way. If the bushing moves in the same direction as the pilot valve, the pilot valve will move farther and take longer to continually raise the oil pressure. This controller's reaction to speed change will be slower, or dampened. Restoring lever in Figure 4 will move the bushing as the pilot valve moves. In this way the controllers' sensitivity is lowered.

The synchronizing handwheel is omitted for simplicity's sake. It's normal location is at link "H."

If turbine load increases to 50 psi, speed will drop. The pilot valve will move up to increase oil pressure and raise the piston. As the piston rises, the bushing will also rise. Oil pressure builds up slowly as the pilot valve attempts to catch up to the bushing. This "coy lady" action of the bushing causes the pilot valve to move much farther than it did in Figure 2, so the oil pressure builds up more slowly. Since the pilot moves through a greater distance, flyball speed covers a greater spread, and the throttling band (regulation) of the control system is wider.

We assumed in Figure 2 that the pilot valve moved two mils to change the oil pressure from 20 to 80 psi. If we arrange the restoring linkage so that the bushing moves two mils for an oil-pressure change from 20 to 80 psi, the pilot then has to move four mils, or twice as far. This decreases sensitivity because the same pilot valve motion now produces only half the oil-pressure change.

If the load increases to the point where 50-psi oil maintains 3000 rpm, the pilot valve must move 1 mil relative to the bushing to produce 50-psi oil. The bushing moves ½ mil for every 1-mil motion of the pilot valve. So the pilot valve must move 2 mils to decrease its distance from the bushing enough to maintain pressure. This 2-mil motion of the pilot results in a flyball position at 2970 rpm. But as before, 50-psi oil is enough to rotate the turbine at 3000 rpm. So the system balances only at a compromise position where oil pressure gives enough steam to hold system rpm at a pilot valve position corresponding to the oil pressure. This steady state (equilibrium) speed is about 2970. The bushing actually moves up a little less than ¼ mil, and the pilot is raised a little less than ½ mil to produce a pressure of about 49.4 psi.

While this system is more stable, note that the speed offset is almost 30 rpm, or double the offset obtained with the unstable high-sensitivity system of Figure 2. Speed regulation is:

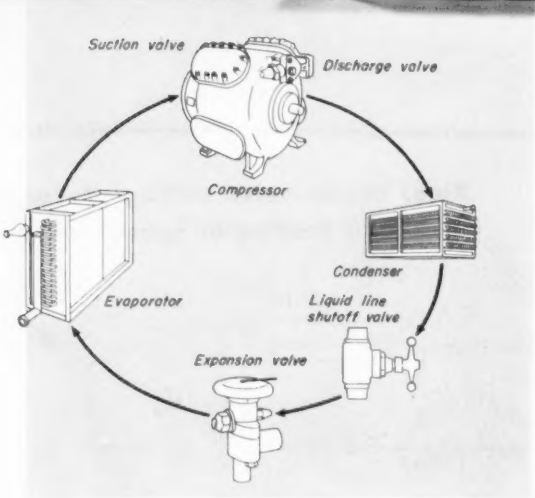
$$\frac{3000 - 2940}{3000} = 2\%$$

Our DR governor has 6% regulation. If we move the bushing 22 mils for an oil-pressure change of 20 to 80 psi, the pilot valve must move 24 mils to change the oil pressure from 20 to 80 psi. This is six times as far as the previous 4-mil movement and results in a speed offset of almost 180 rpm. Speed change from "no load" to "full load" is 3000 to 2820 rpm or 6% speed regulation.

You will often hear the phrase "speed variation" used in talking about governors. This is speed change for which no corrective action has been started by the governor because it hasn't sensed a change in speed; or for which corrective action has started but has not reached the steam valve. Speed variation can't be defined for the system set up in Figure 4 since we do not know the "play" (slop, resistance to motion, backlash, etc) present in the flyball, pistons, valves and linkages.

If every part of the system reacts in the full amount that the part pre-

(*Continued on page* 180)



Do you know what to do when your refrigeration compressor won't run right, or won't run at all? Here's the second of a 3-part guide used by the Trane Co to . . .

Spot refrigeration troubles fast

Trouble	Probable Cause	Symptoms	Recommended Action
C. Compressor runs continuously	1. Excessive load	1. High temperature in conditioned area	1. Check for excessive fresh air or infiltration. Check for inadequate insulation of space
	2. Thermostat controlling at too low a temperature	2. Low temperature in conditioned area	2. Reset or repair thermostat
	3. "Welded" contacts on electrical control in motor starter circuit	3. Low temperature in conditioned space	3. Repair or replace faulty control
	4. Lack of refrigerant	4. Bubbles in sightglass	4. Repair leak and charge
	5. Overcharge of refrigerant	5. High discharge pressure	5. Purge or remove excess
	6. Leaky valves in compressor	6. Compressor noisy or operating at abnormally low discharge pressure or abnormally high suction pressure	6. Overhaul compressor
	7. Solenoid stop valve stuck open or held open by manual lift stem	7. Air conditioned space too cold	7. Repair valve or restore to automatic operation
D. Compressor loses oil	1. Insufficient oil charge	1. Oil level too low	1. Add sufficient amount of proper compressor oil
	2. Clogged strainers or valves	2. Oil level gradually drops	2. Clean or repair and replace
	3. Loose expansion valve or remote bulb	3. Excessively cold suction	3. Provide good contact between remote bulb and suction line
	4. Liquid flooding back to compressor	4. Excessively cold suction. Noisy compressor operation	4. Readjust superheat setting or check remote bulb contact
	5. Short cycling	5. Too frequent starting and stopping of compressor	5. See items under trouble "B" (Part 1)
	6. Crankcase fittings leak oil	6. Oil around compressor base and low crankcase oil level	6. Repair oil leak and add proper refrigerant oil

Trouble	Probable Cause	Symptoms	Recommended Action
E. Compressor is noisy	1. Loose compressor drive coupling	1. Coupling bolts loose	1. Tighten coupling and check alignment
	2. Lack of oil	2. Compressor cuts out on oil failure control	2. Add oil
	3. Dry or scored seal	3. Squeak or squeal when compressor runs	3. Check oil level
	4. Internal parts of compressor broken	4. Compressor knocks	4. Overhaul compressor
	5. Liquid "flood back"	5. Abnormally cold suction line. Compressor knocks	5. Check and adjust superheat. Valve may be too large or remote bulb loose on suction line. Air entering evaporator too cold for complete evaporation of liquid. Or see B-4 (Part 1)
	6. Dirty water regulating valve, too high water pressure or intermittent water pressure	6. Water valve chatters or hammers	6. Clean water regulating valve. Install air chamber ahead of valve
	7. Expansion valve stuck in open position	7. Abnormally cold suction line. Compressor knocks	7. Repair or replace
	8. Compressor or motor loose on base	8. Compressor or motor jumps on base	8. Tighten motor or compressor hold-down bolts
F. System short of capacity	1. Flash gas in liquid line	1. Expansion valve hisses	1. Add refrigerant
	2. Clogged strainer or solenoid stop valve	2. Temperature change in refrigerant line through strainer or solenoid stop valve	2. Clean or replace
	3. Ice or dirt on evaporator	3. Reduced air flow	3. Clean coil or defrost. See B-4 (Part 1)
	4. Expansion valve stuck or obstructed	4. Short cycling or continuous running	4. Repair or replace expansion valve
	5. Excess pressure drop in evaporator	5. Superheat too high	5. Check superheat and reset thermostatic expansion valve
	6. Improper superheat adjustment	6. Short cycling or continuous running	6. Adjust expansion valve. Check superheat and reset thermostatic expansion valve
	7. Expansion valve improperly sized	7. Short cycling or continuous running	7. Replace with correct valve
G. Discharge pressure too high	1. Too little or too warm condenser water	1. Excessively warm water leaving condenser	1. Provide adequate cool water, adjust water-regulating valve
	2. Fouled tubes in shell- and tube-condenser	2. Excessively cool water leaving condenser	2. Clean tubes
	3. Improper operation of evaporative condenser	3. Low air or spray water volume. Scaled surface	3. Correct air or water flow. Clean coil surface
	4. Air or noncondensible gas in system	4. Exceptionally hot condenser and excessive discharge pressure	4. Purge
	5. Overcharge of refrigerant	5. Exceptionally hot condenser and excessive discharge pressure	5. Remove excess or purge

Turn page

Trouble	Probable Cause	Symptoms	Recommended Action
H. Discharge pressure too low	1. Too much condenser water	1. Excessively cold water leaving condenser	1. Adjust water regulating valve
	2. Lack of refrigerant	2. Bubbles in sightglass	2. Repair leak and charge
	3. Broken or leaky compressor discharge valves	3. Suction pressure rises faster than 5 lb per minute after pressure shutdown	3. Remove head, examine valves and replace those found to be operating improperly
	4. Leaky relief by-pass valve	4. Low discharge pressure and high suction pressure	4. Inspect valve to determine if replacement is necessary
J. Suction pressure too high	1. Excessive load on evaporator	1. Compressor runs continuously	1. See Complaint C
	2. Overfeeding of expansion valve	2. Abnormally cold suction line. Liquid flooding back to compressor	2. Regulate superheat setting expansion valve and check to see that remote bulb is properly attached to suction line
	3. Expansion valve stuck in open position	3. Abnormally cold suction line. Liquid flooding back to compressor	3. Repair or replace valve
	4. Expansion valve too large	4. Abnormally cold suction line. Liquid flooding back to compressor	4. Check valve rating table, and replace valve if necessary
	5. Broken suction valves in compressor	5. Noisy compressor	5. Remove head, examine valves and replace those found to be inoperative
K. Suction pressure too low	1. Lack of refrigerant	1. Bubbles in sightglass	1. Repair leak and charge
	2. Light load on evaporator	2. Compressor short cycles	2. See B-5 (Part 1)
	3. Clogged liquid line strainer	3. Temperature change in refrigerant line through strainer or solenoid stop valve	3. Clean strainer
	4. Expansion valve power assembly has lost charge	4. No flow of refrigerant through valve	4. Replace expansion valve power assembly
	5. Obstructed expansion valve	5. Loss of capacity	5. Clean valve or replace if necessary
	6. Contacts on control thermostat stuck on closed position	6. Conditioned space too cold	6. Repair thermostat or replace if necessary
	7. Compressor capacity control range set too low	7. Compressor short cycles	7. Reset compressor capacity control range
	8. Expansion valve too small	8. Lack of capacity	8. Check valve rating table for correct sizing and replace if necessary
	9. Too much pressure drop through evaporator	9. Too high superheat	9. Check for plugged external equalizer
L. Compressor will not run	1. Open line circuit	1. Compressor will not run—no hum	1. Check wiring and fuses
	2. Overload cut out	2. Same as above	2. Wait for reset—check current
	3. Control contacts open	3. Same as above	3. Check controls, check pressures
	4. Open circuit in motor	4. Same as above	4. Replace motor

Tips on air compressor cylinder lubrication

Based on...

- Clean, dry conditions
- Horizontal and inclined cylinders
- Compressor is broken-in
- Gravity drop-feed lubricators used

Cylinder dia, in.	Min oil feed, dpm
6—10	1— 2
10—12	2— 4
12—15	4— 6
15—18	6— 8
18—24	8—10

Note: During break-in, use about double the above feed values until cylinder has a good glaze. Increase the min feed values if compressor operates in a wet or dirty air atmosphere. Divide above values by 2 or 3, where glycerine-filled glass lubricators are used: hold 1 dpm min.

By SIM JESTER
Product Application Engineer
Gulf Oil Corporation

Regulated air and lube oil flow proves key to . . .

Smooth air-compressor operation

Often the solution to a lubrication problem sounds obvious when the reasons are explained, but the man on the job is too close to see it beforehand. An outside expert frequently can spot the trouble, and that is just where the oil supplier's lubrication engineer fits into the picture. Here is a case in point:

A cement-mill superintendent complained that oil was forming heavy hard deposits on valves of one air compressor in his power plant when a new oil was used.

There were two large horizontal 2-stage compressors, one motor driven, the other steam driven. Only the steam-driven unit was giving trouble.

By the time I reached the plant late in the afternoon, the chief had gone home. And the valves had been cleaned up and the unit was back in operation. The second-shift engineer had no details of the complaint and with the compressor back on the line I couldn't check to see what or where the troublesome valve-deposits were.

The only thing to do was to look for obvious, outside troubles. The forced-feed lubricator had four feeds to the air cylinders, one to each end of the low- and high-pressure sides. But almost all the oil went through one feed—32 drops per minute (dpm) to the high-pressure crank end. The feed on that one line was enough for the entire compressor.

It's poor practice to have excessive oil feeding the h-p cylinder since excess oil is deposited on the exhaust port. Heat from the compression cycle tends to keep the h-p exhaust port hot. This "cooks" any material accumulated on the valve. Although a good air-compressor cylinder oil forms a minimum amount of deposit, feeding too much oil encourages trouble. The cylinder oil lubricates the internal cylinder and valve parts and provides a good piston-ring seal. The right amount is the least amount that performs these jobs well.

Feed to the other end of this h-p cylinder was only 8 dpm. Feeds to the l-p cylinder were about 4 dpm to each end.

The erratic oil feed showed the lubricator was in bad shape. With all the oil going to the h-p crank end, there was no doubt that the exhaust valve would show deposits. The l-p cylinder was starved for oil.

They had another problem. Air intake came from the basement. On the end of the 6-in. diameter intake pipe was a box for holding two filter frames side by side, each about 18-in. square. But one of these filters was missing. Someone had thought that since the compressor was overloaded they could get more air out of it by removing one filter. Rust marks around the edge showed it had probably been removed about the same time they (*Continued on page* 196)

NOTE: Above table contains recommendations of one leading compressor manufacturer; they may differ from those of other makers.

Where to look for trouble

Shading coil

Usually copper or brass stamping. Loop may have split open because of vibration. Causes chattering of contacts, or at least, noisy operation. Remedy: braze loop closed or replace with copper wire using long pigtail splice. Fasten tightly.

Magnet-pole face

Must be kept clean, rust free. Gummy dirt can prevent magnet from dropping out; rust or heavy dirt can cause chattering. Remedy: clean with fine sandpaper. If badly worn, file flat. Note: center pole of E-type magnet should not touch or contactor may not drop out.

Coil

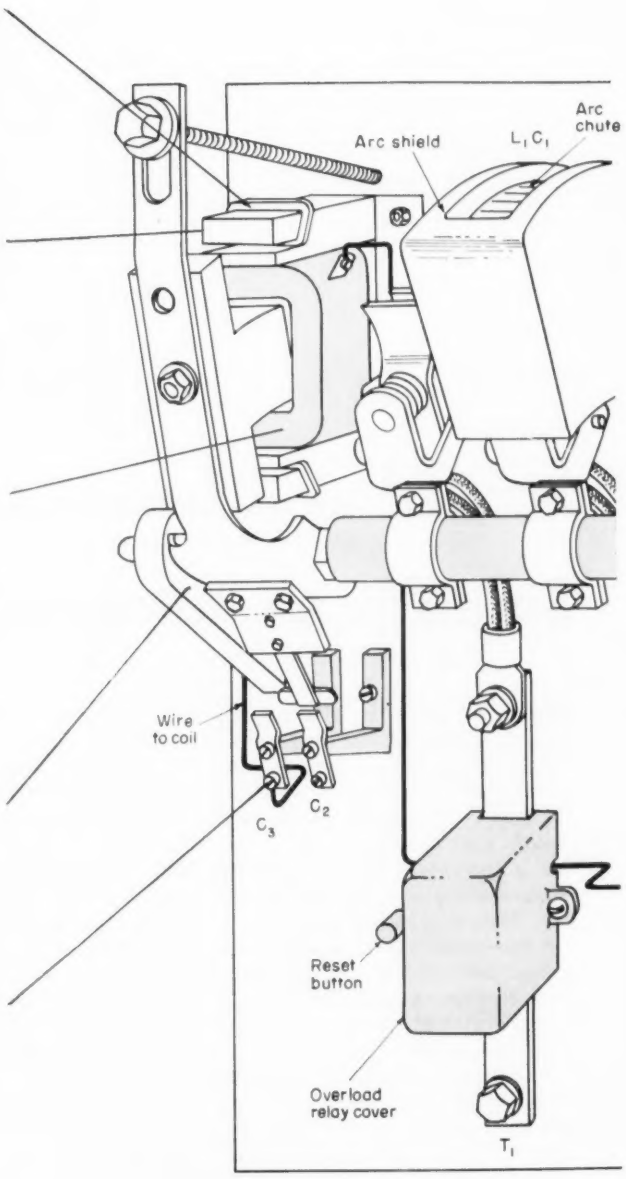
Overheating coil can be caused by overloading (too much contact pressure; worn or misaligned mechanical parts). Also check: pole-faces not seating correctly; wrong coil; shorted coil; too high voltage. Shorted coil or with intermittent open can cause chattering, unnecessary tripping. Remedy: remove coil, check rating, squeeze (coil should be firm, insulation unimpaired).

Mechanical parts

Worn bearings and linkages can cause chattering, unnecessary tripping, poor alignment of contacts and magnet. Remedy: clean, sandpaper, lubricate, realign. If badly worn, best bet is to replace.

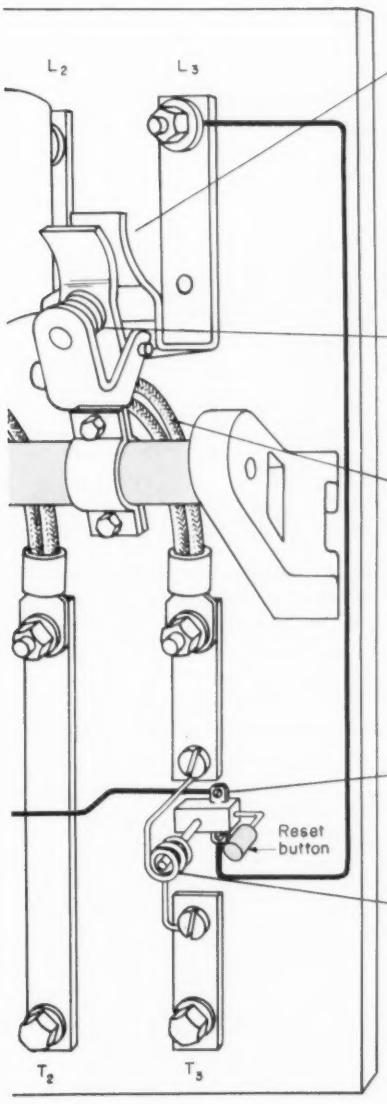
Auxiliary contacts

Poor contact caused by dirty contact surfaces, weakened spring, misalignment, can cause chattering, unnecessary tripping, failure to hold after start. Remedy: clean, realign, check tension.



in ac magnetic starters

By S SPENCE, Cheshire, England



Contacts

Short tip life can be caused by weak contact pressure, interrupting heavy currents (frequent jogging; opening on short-circuit current); chattering; wrong contacts; misalignment; excessive filing. Overheating comes from weak pressure, inductive loads, copper oxide on tips. Remedy: install new contacts of proper rating; check contact pressure with spring scale. Look into operating requirements for possible misapplication of starter. Replacing copper with silver-plated or alloy contacts may help. (Don't file silver or alloy contacts.) Check arc chutes for proper alignment.

Contact springs

Weakened springs cause poor contact pressure. Springs that are too stiff overload magnet, result in chattering. Remedy: best bet is to replace with manufacturer's spring.

Shunts

Burned or broken shunts are due to misapplication (too short, too stiff, etc); corrosive atmosphere. Remedy: check regularly for signs of deterioration; replace only with manufacturer's shunt.

Overload trip mechanism

Damaged by frequent overload or by resetting too soon after tripping. Causes unnecessary tripping, sometimes chattering. Remedy: replace.

Overload thermal coil

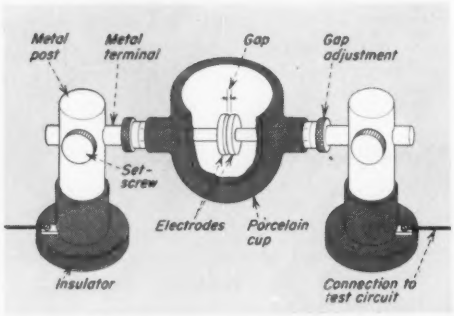
If too small, unnecessary tripping results. If too large, main contacts will carry overload current. Remedy: replace with recommended element, check peformance if test equipment is available. Ambient temperature has effect; never remove cover or other associated parts from relay. Leaving cover off controller may expose relay to drafts.

● Clapper-type starter is shown because it's easier to identify parts. Plunger type has same essential parts, except shunts. Troubles follow same pattern although improved designs minimize them.

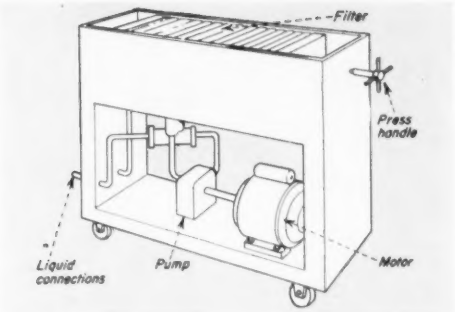
7 standard tests for transformer liquid

Good condition of insulating liquid is vital to life of transformers. Usually the insulating liquid, oil or askarel is well behaved, but it takes only a little contamination to cause trouble. Dielectric tests should be performed regularly. Other tests vary in difficulty. Description of these and other tests are given in American Society for Testing Materials *Standards*. Numbers of standards are listed with each test. Tests are applicable to both oil and askarel. Special considerations for latter are given in *ASTM D901*.

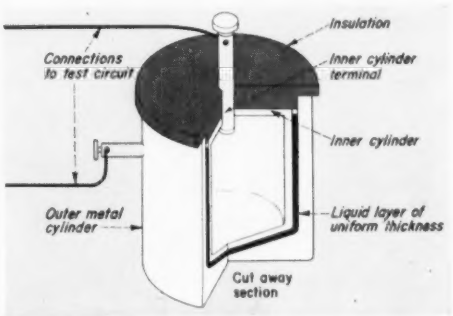
By NORMAN PEACH, Assistant Editor



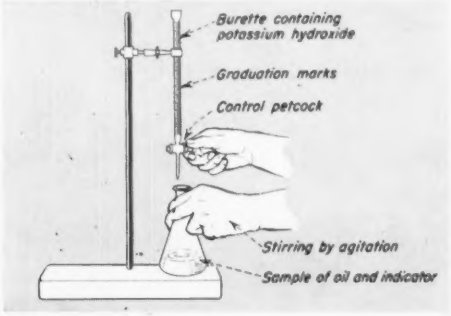
1 DIELECTRIC STRENGTH is measured with portable test set. Place oil sample in clean test cup after setting electrode gap at 0.100 inch with gage. Apply 60-cycle voltage, increasing it until breakdown. Breakdown should not occur below 22 kv for used oil, 25 kv for askarel. Value is average of test on 5 cupfulls. *D877*.



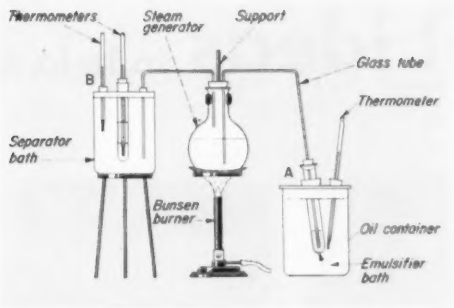
2 SLUDGE DETERMINATION is clue to oil deterioration. Compare relative accumulation of sludge across equal periods between filterings. If it forms rapidly, especially if accompanied by high acidity, oil should be replaced. Judging relative sludge accumulation requires experience. More elaborate tests for sludge are in *ASTM D1313*.



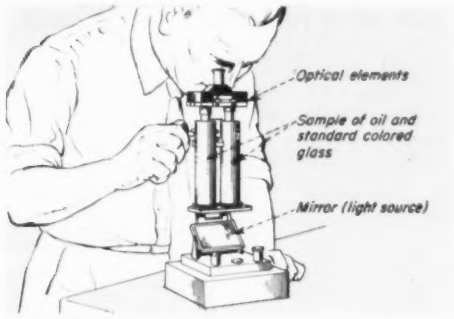
3 POWER FACTOR of oil and askarel helps check its condition. Specific value isn't important, but increase with time indicates changes in liquid. Power factor is calculated by current, voltage and watts, or by bridge methods. Test cell acts like a capacitor with liquid dielectric; measurements must be precise. See *ASTM D924*.



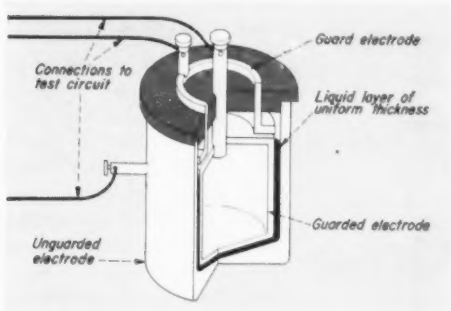
4 ACID NUMBER is number of milligrams of potassium hydroxide needed to neutralize acid in one gram of oil. Acid number for new oil shouldn't be more than 0.03. Number in order of 0.5 to 1 means oil needs attention; may not be serious if sludge isn't present. Color titration is in *ASTM D974*; potentiometric is in *D664*.



5 **STEAM EMULSION NUMBER** is number of seconds required for specific amount of oil to clear out of emulsion formed by blowing steam through cold oil. Low steam emulsion number is desirable; it means water will settle out of suspension readily. For new oil, number should not exceed 25; used oil is greater. See *D157.*

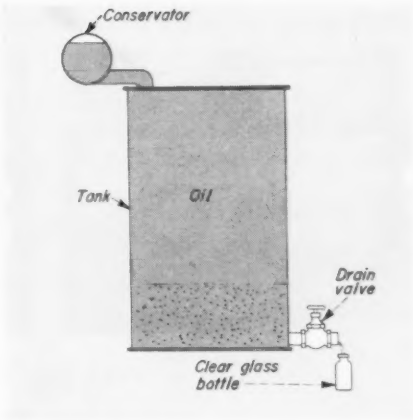


6 **COLOR NUMBER** is obtained by comparing liquid sample with standard glass slides numbered according to color. Specific color of liquid isn't important, but color changes with time indicate aging or deterioration. It's a relatively easy test to make, shows whether more complicated tests are advisable. *ASTM D155.*

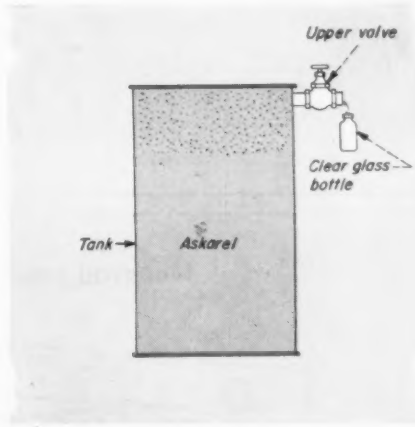


7 **RESISTIVITY** of insulating liquids is not in itself significant, since they are always high. A drop in resistivity indicates presence of water or other contaminants. Power-factor cell can be used, or three electrode (above). Test is relatively simple, but must be done carefully. A megger or a high-resistance bridge is used. *ASTM D1169*

Careful sampling is important

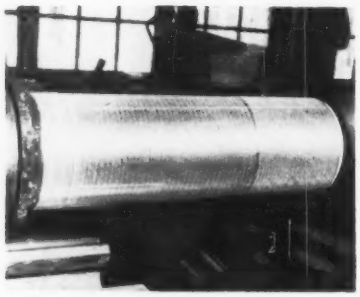


OIL SAMPLE is drawn from bottom of tank. Water, moisture and most contaminants are concentrated in lower portion. Use chemically clean, completely dry bottle and cork; even thumbprint upsets test. Run off some liquid before taking sample, expose sample to air as little as possible. *ASTM D923.*



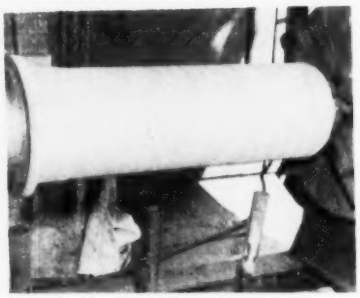
ASKAREL SAMPLE is drawn from top of tank. Askarel is heavy and water, oil and most contaminants are densest in upper portion. Cleanliness is even more important than with oil. Some manufacturers supply special sampling bottles. Thief tubes, if used, should be of glass. *D901.*

Timely **practical ideas** to help solve



Take cut, then knurl

Spray on metal



Keep cool with air

Metallizing is a good maintenance tool, but you must remember these basic steps

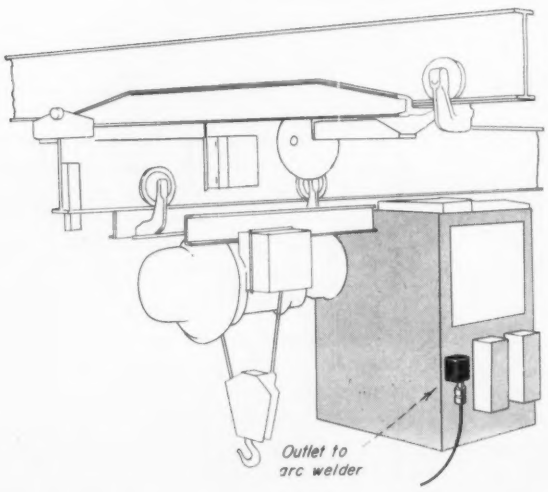
We use metallizing on many repairs in our hydro station. Here's one caution: don't metallize surfaces subject to high impact forces, nor when strength of materials is involved. Shafts, pistons, stems, seal rings etc are ideal for metallizing. For a successful rebuild, make sure surface to be metallized is clean and prepared properly.

Let's say you have a badly grooved or scored shaft. First, set it up in a lathe and take a cleaning cut. Next, cut eight vee's to the inch along area to be metallized. Then, run special knurling tool along the top of the vee's, to give a very rough turned-over thread. Remember: metallizing depends on a mechanical bond only, there's no fusion of metals. After knurling, to insure a still better bond, we use a wire known as *Fusebond*. This is a high nickel wire and therefore expensive. Two passes with the gun are enough.

Depending on type of job, spray metal to diameter required. There are several classes and types of "wire": mild steel, copper, bronze, babbitt, zinc and two types of stainless steel—one machinable, the other not. We have applied stainless over bronze surfaces with complete success. Don't use *Fusebond* on bronze. When a job is built up to the correct thickness, machine and grind if necessary. Follow these simple steps and your metallizing jobs should last.

L McWILLIAMS, *Shawinigan, Que.*

Monorail crane serves as auxiliary power supply



With the ever-increasing use of arc welding, an ample supply of heavy-duty outlets is necessary to keep the dc leads as short as possible. This avoids line drop and doesn't clutter busy shop floors with cables.

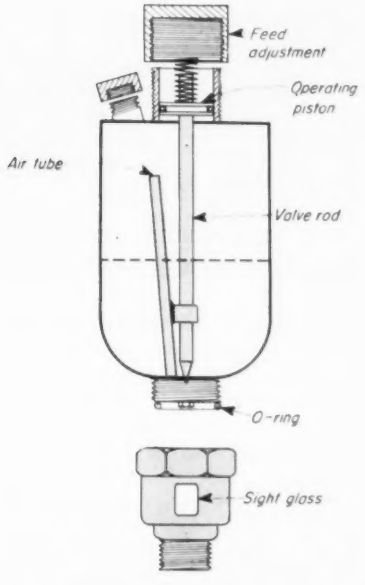
We rigged up one auxiliary outlet that is always with the crane wherever it moves, sketch. Our outlet and disconnect switch are mounted to the crane cab's outer wall. It can be reached with ease by the crane operator, who pulls the three conductor cables and plug up to him with a hand line he carries in his cab.

Device works fine for short-term emergency jobs, saves time.

P C ZIEMKE, *Clinton, Tenn.*

your tricky design and maintenance problems

STEVE ELONKA, Associate Editor



Here's a good way to seat lubricator valve rods

Seems that everyone who uses pressure-type lubricators first removes the adjusting cap. Then the valve rod is usually taken out of its seat, but isn't replaced properly. This is easy to understand because you can't see, and it's almost impossible to feel, when rod is seated.

We sawed the container in half, sketch, and welded a close-fitting valve-rod guide to the air tube. Now it's easy to push the valve rod through the guide, which always centers the rod in its seat. After the guide was located accurately and brazed in place, the two container halves were welded together.

L S FRAHS, *San Francisco, Calif.*

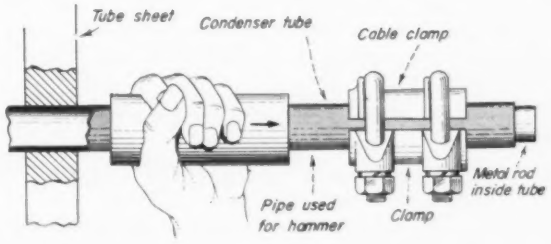
What would you have done?

One row of tubes in our watertube boilers is very hard to clean. The tube cleaner jammed around the bend and out of sight and reach. Cleaner is an air vane motor type, with cutters thrown out by centrifugal force. Tube ID is 2⅝-in.

After trying a number of suggestions we were going to cut a hole in the tube. I requisitioned a new brass ball of 2½-in. diameter originally intended for a ball-check valve. We put the ball into the bottom of the tube, followed by a tapered wooden plug with a ½-in. pipe center. We then put a ½-in. brass cock on the fitting and connected an air hose with all ½-in. fittings. My thought was to send the ball up the tube with enough velocity to hit the cleaner and loosen it.

But it didn't work. The ball just didn't seem to gather enough velocity to make the vertical climb. "Undo that hose," I said, "and fill it with water." The weight of water hit the ball and got it rolling. The air carried the ball up the tube, it hit the cleaner and out it came. What would *you* have done?

G C LEWIS, *North Burnaby, B. C.*



Cable clamp helps remove stubborn condenser tubes

Removing stuck condenser tubes isn't easy, especially from large condensers. This job is an added headache when tube isn't in line with inspection doors of waterbox. We solved problem by placing iron plug into end of defective tube, sketch. Then we put a cable clamp around end of tube and used short length of heavy piping as hammer.

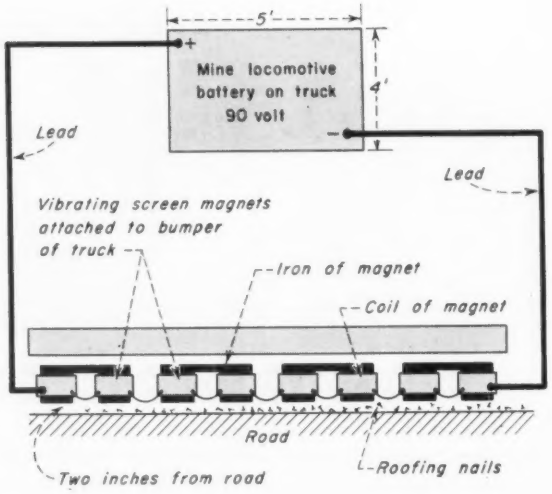
This clamp-and-pipe hammer idea can be used for all kinds of heat-exchanger tubes that scale up on outside. Then removing tubes is easy.

G G AVANT, *Wilmington, N. C.*

Do you know...

that carbon on atomizer tips is the surest sign of improper location of tips? If atomizer is too far in, eddy is formed in entering air currents. A fine fog of oil is drawn back behind the tip's face; is deposited back on atomizer pipe, forming carbon.

Turn page for more Practical Ideas ▶



Here's an emergency nail picker-upper

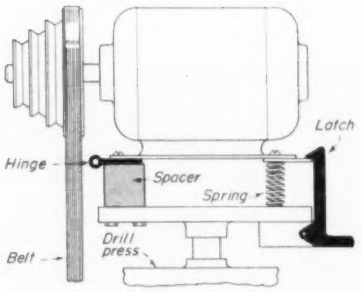
During an illegal strike in a mining and smelting town years ago, most of the men wanted to work while negotiations were going on. More rabid strikers waylaid the workers, beat them up and resorted to other sabotage. Company put on a fleet of trucks to pick the workers up at their homes and transport them to work.

As a countermeasure, the strikers strewed the road with large flat-headed roofing nails that tied up transportation.

One of the engineers came up with an idea, but was bucked by the chief electrician. Idea was to use ac magnets from the vibrating screens in screening plant, make dc magnets of them and install them on front of trucks to pick up nails. Chief electrician claimed it couldn't be done.

After a little experimenting, four vibrating screen units were connected in series, sketch. Our engineer connected them to a 90-volt battery from the mine locomotive. Supplying juice to magnets' coils gave him a very powerful dc magnet. Nails were picked up by the bushel. One day's operation put an end to the strikers' nail laying stunt. Since then I have had a chance to use this idea in other ways around various jobs.

L McWilliams, *Shawinigan, Que.*



Now belt is easy to change

Our drill-press operators complained about shifting belts on their machines. They had to pry the belt from the V-groove, which meant releasing the clamp screws on the motor mount. Then motor had to be reset.

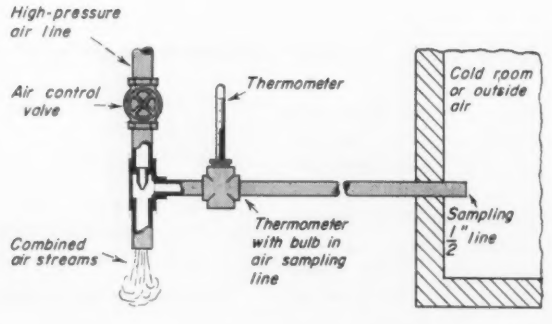
To solve this problem, we added a hinged plate and latch on motor base, sketch. With this rig, it's easy to change the speed. Result: Fewer drills are burned up and broken because now drills run at proper speeds.

E Jones, *Bronx, N. Y.*

Do you know...

why some gaskets keep blowing out shortly after being installed? *Plant Operators' Manual,* McGraw-Hill Book Co, tells you. Over 1600 sketches explain problems in great detail, show you how to solve them.

Homemade gadget for reading remote temperatures



Taking temperatures from remote places is easy with hookup, sketch. But you need an air line of about 100 psi and the syphon or mixer, shown. Make sampling line of ½-in. fittings. Then install thermometer with its bulb sealed in the air stream. When syphon operates, the drawn in air from cold spaces will register correct temperature on the thermometer.

C Holloran, *Toronto, Que.*

Turn page for more Practical Ideas ►

Wide Size Range . . . in Any Quantity . . .
Builds UTILITY Demand for
B&W HOLLOW FORGINGS

Leading electric utilities—like American Gas and Electric, Carolina Power & Light, Commonwealth Edison, and Wisconsin Electric Power—use B&W hollow forgings for main steam, reheater, feedwater, and similar lines. B&W hollow forgings give them a sound solution to their piping problems.

These heavy-duty forgings can be specified to exact design requirements. They are made from high quality carbon, alloy, and stainless steels. They are produced with vigilant care under controlled conditions from the initial melt through final inspection. That's why B&W hollow forgings give users savings in time and money.

For additional information, write for Bulletin S-16. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

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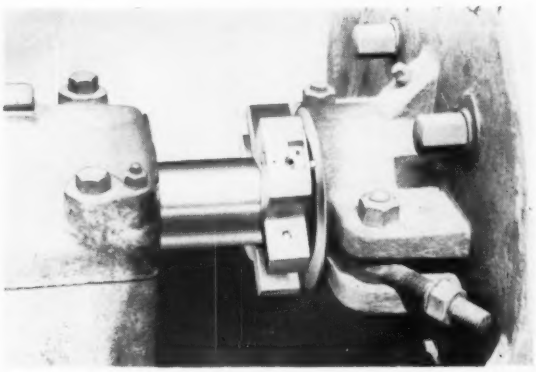
S-473-HF

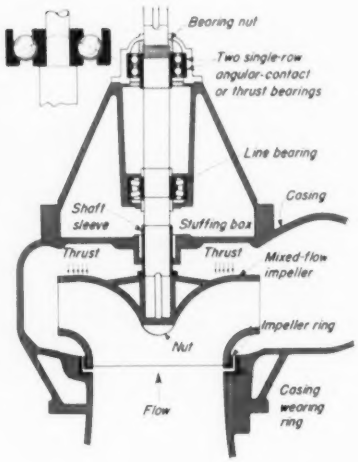


New tool faces pump for mechanical seal

New hand tool, photo, prepares pump stuffing boxes for mechanical seal installation. This stuffing-box refacing tool prepares a smooth gasket surface on end of stuffing box. Consisting of a tool bit and holder, the tool machines the stuffing-box end at right angles to the shaft axis. Tool bit holder mounts on the shaft with the tool-bit against the stuffing-box end. Bit is adjusted to bore and is worked outward by turning the shaft with a stillson or strap wrench.

Mechanical seals must be installed properly to eliminate stuffing-box repacking and maintenance. Seal solves problem of leakage in most pumping services. A smooth stuffing box end, machined at right angles to the shaft axis, is a must for proper installation. With this new refacing tool, you can reface and install a mechanical seal quickly and easily.

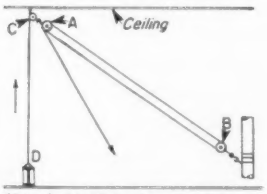
Courtesy, Byron Jackson Pumps, Inc



Which way is pump thrust?

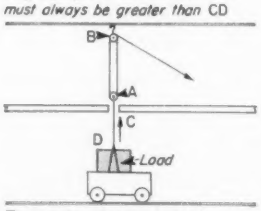
Did you know that the thrust of a single-suction pump shaft is toward the intake flow, never with it? Discharge pressure will always exert a greater force against the impeller than the intake flow, regardless of whether there is a head or a vacuum at the intake, sketch. Knowing this can help you to avoid ruined thrust bearings and extra downtime from installing bearings backwards.

F J ARDOLINO, *Brooklyn, N.Y.*



Note: In this hitch, dimension AB must be greater than CD. Any source of power can be used

To get proper drift dimension AB must always be greater than CD



To speed up job, load weight on a high cart. One lift at location completes job

You can raise loads up to ceiling

Has a large rope block ever kept you from raising a heavy item close enough to the ceiling? Next time, use the smallest, lightest single-rope block that will support the load and fit the rope size. Hookup shown, first sketch, permits mechanical advantage of a multirope pulley system without sacrificing lifting height. Just make sure distance between the two large blocks is a bit greater than distance through which load must be raised.

Second sketch shows a method that can sometimes be used to lift a load right up to the ceiling. Pulley system shown, or one suggested in first sketch, may be used depending on how high you can hang the upper block. Again, remember that distance between the two large blocks must be a bit greater than the distance through which you are going to lift the load. Starting load from a higher level, of course, reduces this distance and makes job easier.

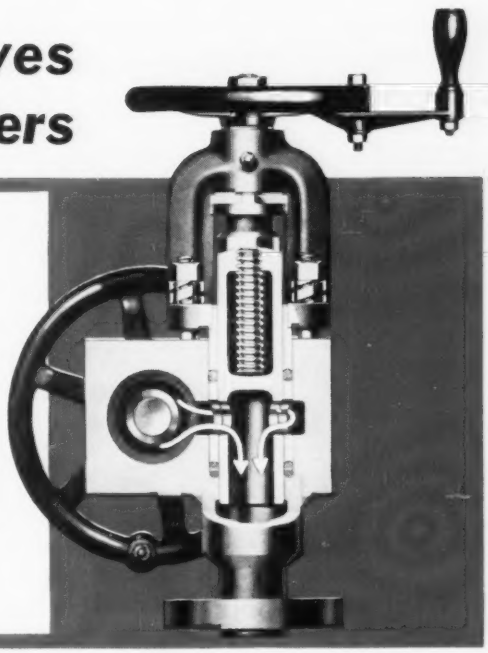
H B MCDERMID, *Long Beach, Calif.*

My biggest boner

Please turn to page 188.

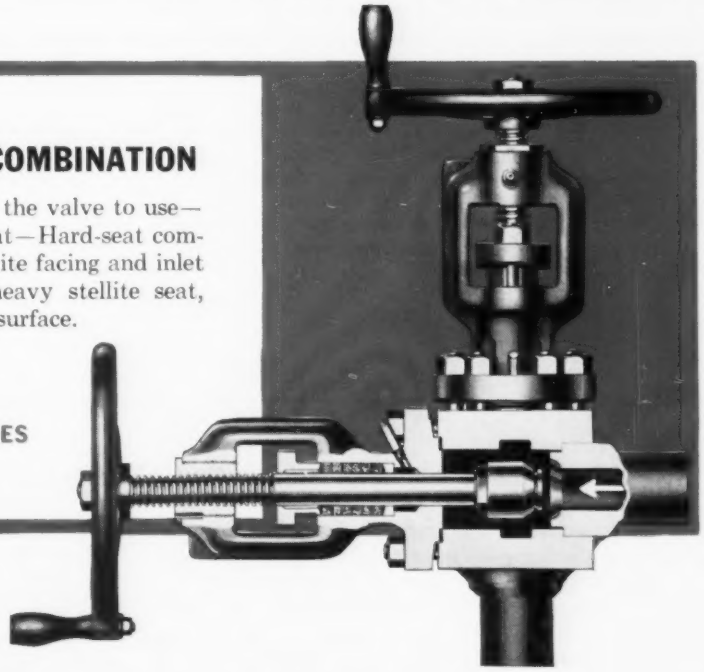
UNIT TANDEM

rugged blow-off valves for high pressure boilers



HARD-SEAT—SEATLESS COMBINATION

■ For boilers up to 1500 psi, this Yarway Unit Tandem Blow-Off Valve offers the maximum in dependable service. A one-piece forged steel block serves as the common body for the Yarway Stellite Hard-seat blowing valve and the Yarway Seatless sealing valve. All interconnecting flanges, bolts and gaskets are eliminated. The Unit Tandem at right is sectioned through Seatless Valve to show balanced sliding plunger in open position and free flow.



HARD-SEAT—HARD-SEAT COMBINATION

■ For boilers to 2500 psi, this is the valve to use—Yarway's Unit Tandem Hard-seat—Hard-seat combination. Disc has welded-in stellite facing and inlet nozzle has integral welded-in heavy stellite seat, providing smooth, hard-wearing surface.

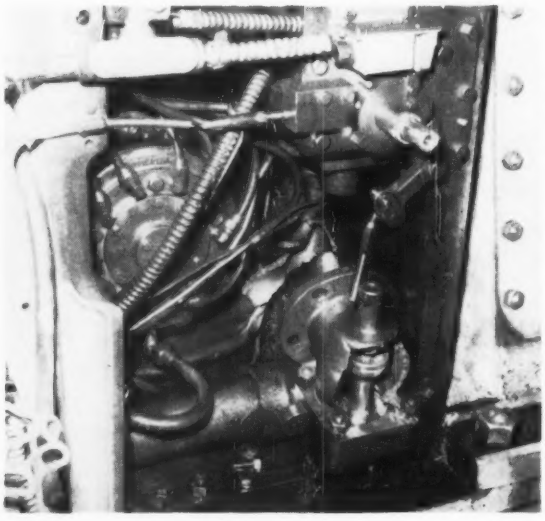
OVER 4 OUT OF 5
HIGH PRESSURE PLANTS
USE YARWAY BLOW-OFF VALVES

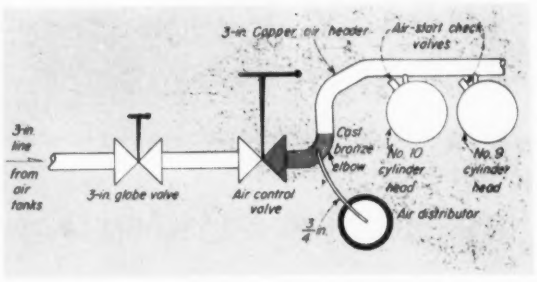
Write for Yarway Catalog B-434

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY **BLOW-OFF VALVES**

These **plant problems** could well be yours...





What caused this dual-fuel engine starter housing explosion?

I'm superintendent of a plant that's equipped with four 3500-hp dual-fuel engine-generators. We furnish power to a ten-county area without tie-ins to other systems.

Recently, one of our regular shift operators was starting No. 2 unit when an explosion took place in the starter housing, injuring the operator and damaging the engine quite extensively in the vicinity of the air control valve.

When the explosion took place, the operator had just gone through the normal routine of starting the engine. He turned the upper lube pumps by hand, started the jacket-water pump, started the lube-oil pump, opened the 3-in. globe valve on the starting air line and then depressed the control handle to the start position. He later said that the engine had turned over several times when the explosion took place.

Upon hearing the loud explosion we shut off all gas valves because we first thought a gas header had exploded. The plant filled with a dense smoke and it was difficult to see any distance.

Measures were taken to balance the load on the two engines that were running, as they were both on emergency overload operation.

Upon further investigation we saw that the explosion took place inside the starting air valve and in an adjoining bronze elbow. Force of the explosion completely destroyed the valve and fitting. Several copper lines were damaged and the housing casting was broken, drawing and photo above.

Can readers tell us what caused the explosion and what action should be taken to prevent a recurrence?
—*AAF, October Power*

The solutions

Did the starting air valve stick open?

Having experienced similar explosions, I believe the following information may be a clue to finding the cause of the explosion in *AAF's* plant.

As the operator said, the engine made several revolutions before the explosion. It's possible that the starting air valve stuck open on one of the cylinders, allowing the compressed fuel mixture in the cylinder to have a path to the starting air piping.

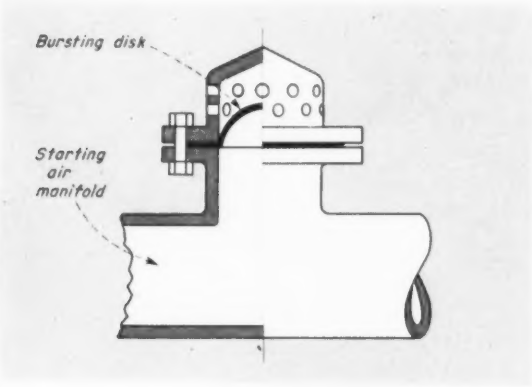
The fuel mixture fired on the compression stroke. And with the starting air valve stuck open, pressure in the starting air line probably increased to over 1000 psi. The bronze valve body—weakest link in the piping—then failed.

Report of dense smoke bears out the theory that the explosion originated in the engine cylinder. I suggest that *AAF* examine and put all starting air valves in the engine cylinders on a frequent maintenance schedule.

W R Pender, *St. Petersburg, Fla.*

...Here's how *Power* readers would tackle them

HOWARD KALLEN, Associate Editor



AAF needs right maintenance and safety procedures

It looks as though one of *AAF's* starting air valves stuck open, allowing the cylinder to fire into the starting air header and ignite an oil deposit. This is indicated by the operator's statement that the engine turned over a few times before the blast, and from the photo and sketch showing the rupture to be at a low point in the header where oil would tend to collect.

Since starting air valves just operate for short periods, they should get extra attention. It's a good idea to work them manually, if possible, before starting up. Lubricant should be used sparingly to prevent sticking due to carbonizing. Pieces of carbon can be hammered into the seat, causing dangerously high pressures at start-up. Leaking valves can be detected with the engine stopped. Disconnect the air distributor pipes and, with pressure on the header, listen at the cylinder air-suction inlet pipes.

Safety devices fitted at the middle and both ends of the header should be capable of relieving any dangerous pressures generated. Spring-loaded valves are too slow because of spring size required. Bursting disks are safer. Type shown in sketch, above, has been used successfully for many years in heavy marine diesels.

Caution: Sometimes the disks weaken because of fatigue or corrosion and may blow at normal working pressure. This can be a nuisance, especially if a unit has to be put on the line in a hurry. But a blank steel bush with a sliding fit can be slipped over housing holes, allowing job to be started and new disk fitted later.

R F HAWKINS, *Montreal, Canada*

Want help with your plant problems? Send your design and operating headaches to us. We'll put *Power* readers to work on them

Explosion in *AAF's* engine room recalls a similar accident

In 1943 I was chief engineer of the motorship *Baltic*, equipped with two 2500-hp two-cycle engines and solid fuel-injection systems. Starting air was supplied to the motor from four 1000-lb storage receivers through a reducing valve for each engine, at 450 psi.

While at sea, both motors were stopped on orders from the captain, and were about to be reversed at full speed. At that time an explosion took place in the motor room. Everybody thought we were torpedoed. The motor room was full of black smoke and it took us a few minutes before we could find the cause of the explosion and extent of the damage. The first assistant engineer and his assistant were slightly injured from flying metal parts. The starting air lines from the reducing valve to the cylinder heads were ruptured and twisted. The two h-p storage bottles were empty and the cylinder head of No. 3 cylinder of the port motor was cracked.

After isolating the damaged lines we were able to start the starboard motor, and take refuge in the harbor of Miami, Fla. Examination showed that the starting air valve in No. 3 cylinder was broken and lodged inside the cylinder. Naturally, the starting air line was left open much longer than it should have been. And when fuel injection took place, the explosion was extended to the entire starting air system.

In our case the broken starting air valve was probably the cause of the explosion. Also, fuel injection must have taken place earlier, causing severe pre-ignition. Thus, combustion pressure was far in excess of the safety limits of the materials.

C P ZANNARAS, *Baltimore, Md.*

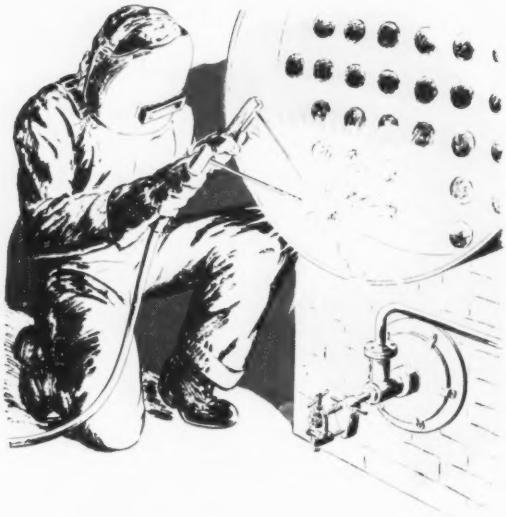
Be sure to check these points

The heavy smoke cloud was almost surely caused by the engine running for a few revolutions after the air check was destroyed, allowing partly burned gas to escape to atmosphere.

AAF should check starting air valves to make sure they're in good working order. Air compressors shouldn't be "pumping oil." Injectors must operate correctly—should not leak during shutdown periods and allow raw cold oil to enter cylinders. Injector pump should be set so peak cylinder pressures aren't excessive during acceleration. This could hasten failure of attached cylinder parts, including starting air valves.

J H GRAHAM, *Seattle, Wash.*

Turn page for info on boiler repair ►



The problem

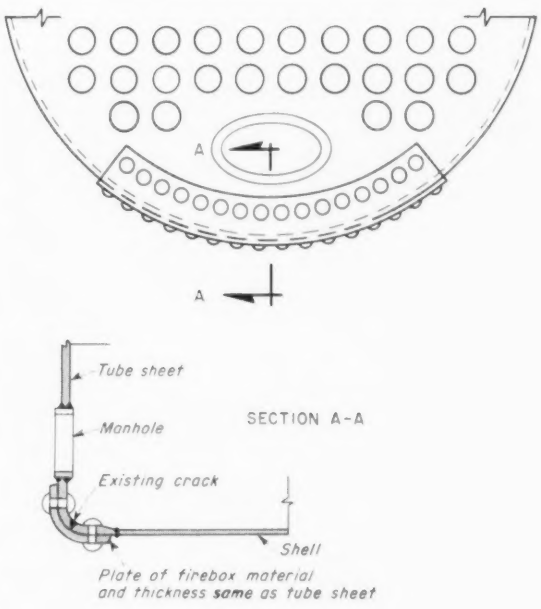
How should this boiler repair be made?

We have an hrt boiler that has developed a circumferential crack in the knuckle of the front tube sheet, below the bottom manhole. This is a fatigue crack from the inside, and extends up both sides of the sheet approximately 18 inches but does not completely penetrate the metal. Our boiler inspector says no welding should be done in the knuckle of an unstayed head, but this tube sheet is supported by diagonal stays. And the tubes themselves have staying power.

Since this boiler is of all-welded construction, it seems to me that the practical repair would be to weld the crack instead of cutting out and replacing a section of the tube sheet all the way back to the head seam. Also, it is difficult to uniformly stress relieve so large a weld in the field.

I'd like readers' opinions.—*HMP, October Power.*

The solutions



Here's how I would do it

HMP can repair his boiler with a plate forged around the knuckle of the tube sheet, with long extensions behind the ends of the visible crack. Plate should be riveted as shown in my drawing, above.

J Boresta, *West Englewood, N. J.*

Boiler inspector was generous

A total crack length of 36 inches is considerable because we are dealing only with the area below the tubes. And, more important, we are talking about damage that is detectable by eye.

HMP's boiler inspector has certainly given him every advantage. Cutting out the lower segment that comprises the defect, back to the head-to-shell seam, would be the minimum repair needed to operate the boiler safely. The boiler inspector should be commended for bringing to light a condition that could have been disastrous.

This boiler is probably not more than 10 or 12 years old (all-welded construction). So cost of repairs should be weighed against cost of a new shell.

Stress relieving shouldn't be too difficult, since the head thickness is probably only ½ inch. This would require uniform heating six inches on either side of the seam to a temperature of 1200 F. Slow cooling could be accomplished by insulating the area.

E C Cox, *York, Pa.*

For more on boiler repair and new problems, turn page ▶

Now . . . Electronically Tested Condenser Tubes from Bridgeport

In addition to regular ASTM specification tests, Bridgeport Condenser Tubes may now be checked by ultra-sensitive, electronic tube inspection equipment. These modern nondestructive testing devices check each tube to insure that it is free from flaws, cracks, seams and slivers—differences in cross-sectional dimensions and chemical composition.

This testing method is fast and accurate. It eliminates human errors. In operation, the tubes pass through a magnetic field at a uniform speed. Flaws in the tube, which interrupt the pattern of the field, are instantly sensed by an electronic detector which signals acceptance through an oscilloscope and by audio and visual signals.

Electronic testing is just one of many fabricating and testing procedures used by Bridgeport to maintain its high standards of quality and workmanship and to give you better, more economical tube performance. It's in keeping with the requirements that must be met in today's increasingly critical operations.

Make use of Bridgeport's long experience and thorough familiarity with the manufacturing of condenser and heat exchanger tubes. Call your nearest Bridgeport Sales Office on your Copper, Admiralty, Aluminum Bronze, Aluminum Brass, Cupro Nickel, Duplex or other tube requirements.

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More **plant problems**

Begins on page 134

Boiler inspector was right

I agree with the boiler inspector's decision. Welding, unless suitably stress relieved, would not be a satisfactory repair method. Because of the extent of the welding repairs required in this boiler, and also considering that other parts of the unit may fail, I don't think it can now be operated safely above 15 psi. It could still, however, be used as a low-pressure heating boiler.

Boilers of 15 psi and below are considered low-pressure units. Thus, welded repairs may be carried out without X-ray or stress relieving.

The fatigue crack is difficult to repair because of its position. And since gouging of the crack is essential for good repair, it's not practical to do it from the inside. However, the crack can be repaired by gouging from the outside and then welding.

J BAILLIE, *Downsview, Canada*

What caused fatigue crack?

HMP describes the crack in the knuckle of the tube sheet as a "fatigue crack." Regardless of the type of repair used, the crack may reappear. He should try to find out cause of this fatiguing—too rapid warm up, possible settling of the boiler, etc.

Code specifications state that "Field repair of cracks at knuckle or turn of flange of the furnace opening are prohibited unless specifically approved by the enforcement authority." Since the inspector must pass on any repair, he should specify proper method to use.

G R DIEGLE, *Marion, Ohio*

Lacey's error . . . Letter from J I Lacey, October *Plant Problems*, page 136, says that hooking a 10-kw, 460-v heater, to 230-v service would reduce output to 5 kw. Correct figure is 2.5 kw.

Your January problems

How should we modernize water-treating facilities?

I'm power engineer for a large industrial plant that's modernizing its water-treatment facilities as part of a general power-services modernization. After considering our steam and electrical load, we've decided to add a 900-psi 750-F 150,000-lb-per-hr boiler and an automatic-extraction h-p turbine-generator. We generate our own byproduct power, use local utility for standby.

Our raw-water analysis runs about like this:

Ca as $CaCO_3$	80 ppm
Mg as $CaCO_3$	45 ppm
Na as $CaCO_3$	8 ppm
HCO_3 as $CaCO_3$	122 ppm
CO_3 as $CaCO_3$	0 ppm
OH as $CaCO_3$	0 ppm
Cl as $CaCO_3$	3 ppm
SO_4 as $CaCO_3$	8 ppm
Silica as SiO_2	5 ppm
CO_2 as CO_2	5 ppm
pH	7.7
Turbidity	40 ppm

We are replacing a hot-lime-soda water-treating plant built during the early thirties. Because of process contamination we average about 50% makeup water. Condensate returns account for the balance. Older boilers include six 250-psi 25,000-lb-per-hr units. I would like to get opinions of POWER readers on the type water-treating equipment they would consider most practical for our new power plant.—*FRH*

What's best way to light off boilers?

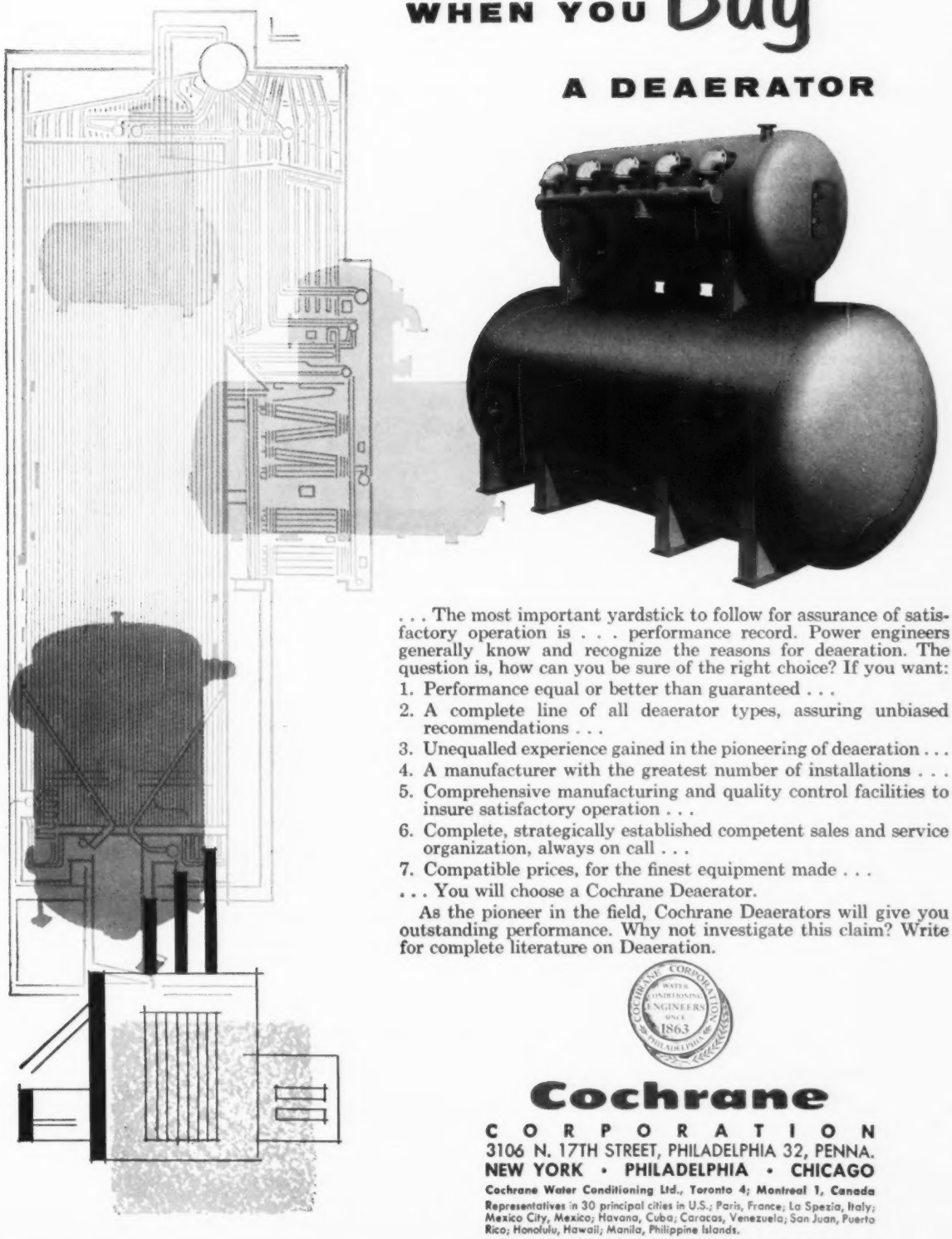
In our plant we have several watertube boilers which are fired with oil. Three are combination gas and oil. In lighting off these boilers it has been customary to use a plant-made lighting torch, prepared from a length of rod. Head of the rod was made by winding several layers of asbestos rope around the end and securing it with iron wire. The torch was then dipped in kerosene and used to light the burners.

This works fine for a short time, until the torch has been dragged in and out a few times. But it soon becomes ragged and is useless.

I wonder if POWER readers know of a better way to perform this operation—possibly some solid substance capable of standing up under hard use, yet porous enough to absorb kerosene and stay lit under momentary blasts of forced draft. Or, perhaps an entirely different method would be better.—*LW*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

WHEN YOU Buy A DEAERATOR



. . . The most important yardstick to follow for assurance of satisfactory operation is . . . performance record. Power engineers generally know and recognize the reasons for deaeration. The question is, how can you be sure of the right choice? If you want:

1. Performance equal or better than guaranteed . . .
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5. Comprehensive manufacturing and quality control facilities to insure satisfactory operation . . .
6. Complete, strategically established competent sales and service organization, always on call . . .
7. Compatible prices, for the finest equipment made . . .

. . . You will choose a Cochrane Deaerator.

As the pioneer in the field, Cochrane Deaerators will give you outstanding performance. Why not investigate this claim? Write for complete literature on Deaeration.

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Your page for **comment** on the ever-changing power scene

BOB BELLAS, Assistant Editor

Watch electrolyte temperature

You have done a fine job on the overall picture of liquid rheostats (POWER, Dec 1957, pp 124-126). However, I'd like to inject a word of caution concerning their general use. Electrolyte temperature is a critical variable which affects the unit's resistance and may precipitate some of the dissolved salts. Temperature must be as stable and constant as feasibly possible. Shutdown periods, particularly if ambient temperature varies widely, require extra caution. We usually insist on supplementary thermostatic control of electrolyte temperature to guard against unsatisfactory operation.

K B HOFFMAN, *McConathy, Hoffman & Assoc, New York, N. Y.*

Desire begets know-how

In asking "Who'll provide the training?" (POWER, Nov 1957, p 140), F L Sanders raises a good point, but overlooks some important facts: (1) Each POWER issue contains easily-digested chunks of information about modern equipment design and operation. (2) There is a wealth of knowledge to be gotten from manufacturers' ads and bulletins. I am sure they are waiting for him to ask for them.

S C STICKNEY, *Tonawanda, N. Y.*

. . . an easy solution is to read POWER. This goes a long way in keeping all hands abreast of what's going on. Further, before signing on the dotted line for new equipment any plant can get plenty of dope on: preparation before arrival, care and feeding etc, trouble shooting and parts lists which should include specs on component pieces. Sanders could make a list of all items in which he'd be interested, get detailed info and study it.

Another angle is to stay close to the manufacturer's representative who's generally around for the first few days that any important equipment goes into service. This gives the operator a chance to see the bugs and ask questions before he takes over. (P.S. Keep a camera handy if possible. It's a lot better than your memory.)

G W CLARKSTONE, *Toronto, Ontario*

. . . this always has been, and always will be a problem for men handicapped by lack of a sound education. But there are *good* correspondence courses to be had and a letter to an equipment manufacturer generally produces an eye-opening bulletin on his product. Build a reference file of these—then it's a case of study, man, study.

R J HUNTER, *Alberta, Canada*

. . . all the needed dope is in equipment manufacturers' bulletins and instruction manuals. True, some of them could be written a lot more simply, but even with the confusing ones there's always someone around the plant who can unravel it for you. I wouldn't work for a chief who kept the information locked in his own files, or for management that would let him get away with it.

E J ROSS, *Columbia, S. C.*

. . . a little midnight oil can keep the complex-equipment waves from breaking over his head.

KEN VILLET, *Houston, Texas*

Flyash "sputnik"?

Touring Europe recently, I was impressed by the trend toward profitable utilization of boiler flyash. Germany in particular is doing it on a big scale. In Hamburg, a plant is producing over 20 million bricks a year. A newly-built plant in Bremen, representing a $1¼-million investment, is booming.

Resulting brick have over 2100 psi crushing strength, depending on flyash characteristics and ratio of flyash to lime. Heat resistivity is 0.3 as compared to 0.8 for ordinary brick. Specific gravity of 1.7 shows a somewhat lower weight and density than ordinary brick.

Brick quality is unquestionably good, and the Germans seem to be solving the aggravating problem of flyash disposal. Are U.S. engineers standing by while another "Sputnik" sails overhead?

C W STEVENS, *Fort Worth, Texas*

EDITOR'S NOTE: *Since he didn't mention it, we assume Reader Stevens didn't visit the new flyash sintering plant at the Central Electricity Authority's Battersea Station in Great Britain.* POWER'S *75th anniversary (Sept 1957) issue, p B-51 will give him the basic facts on this major use of Sinterlite Limited's process for utilizing waste materials.*

The search for Porter-Allen

If you've ever had a yen to be a private eye, here's your chance. The Smithsonian Institution, U.S. National Museum, Washington 25, D.C. is mighty anxious to put the finger on a small Porter-Allen high-speed steam engine. It's a rare type machine and shouldn't be allowed to escape being preserved for posterity.

Anyone knowing the whereabouts of any member of this fast-dwindling gang is urged to notify R M Vogel, Associate Curator, Division of Mechanical and Civil Engineering, at the above address.

Why Every Steam Heated Unit Needs its Own Steam Trap

. . . the theory, practice and proof of "unit trapping" for top temperatures

Using an individual trap for each steam heated unit, including each separate coil, chest or chamber of a machine—pays off for the user. Here are just two examples:

1. On a creamery dryer

Drainage Method	*Air Temperature*
Restricted Blow-thru	250°
Group trapping (1 trap for 8 coils)	225°
Armstrong Unit Trapping (8 traps—1 for each coil)	**309°**

2. On a platen press

Drainage Method	*Processing Time*
Restricted Blow-thru	50 minutes
Group Trapping	35 minutes
Armstrong Unit Trapping	**25 minutes**

Why Unit Trapping Works Best

It is reasonable to assume that no two steam heated units will have *identical* condensing rates. Even the slightest difference in rate will cause a difference in steam pressure drops through the units. Here's where the trouble starts. Condensate from each unit may flow to the trap. But, what about air and other non-condensibles in the system? A difference in pressure drops too small to be indicated by an ordinary pressure gauge will permit backflow of steam from the higher pressure units to the lower pressure units. This backflow of steam may even impede flow of condensate from the lower pressure unit to the trap . . . and it will definitely impede or block off flow of air to the trap. The result is sluggish heating, reduced temperatures, reduced output, fuel waste and increased possibility of corrosion. Figures 1, 2 and 3 diagram the action.

Unit Trapping Not Costly

No engineer wants any more mechanical devices in his plant than are absolutely necessary. But, the moderate additional cost of using two or more small traps, instead of one big one, is saved over and over again in improved efficiency.

If the traps are Armstrong, maintenance is no problem. And users frequently tell us that Armstrong traps outlast others two and three to one.

Steam traps usually represent a fraction of 1% of the cost of the equipment they drain. Does it make good sense to lose 10% or more of equipment capacity to save a few dollars on traps?

Why not test Armstrong unit trapping in your plant. If you are not completely satisfied with the results you can return the traps for a full refund of the purchase price. There is little to lose—lots to gain. Call your local Armstrong Factory Representative or Distributor, or write **Armstrong Machine Works, 8121 Maple St., Three Rivers, Mich.**

ASK FOR the 44-page Steam Trap Book and reprint of article on Unit Trapping.

801ST

ARMSTRONG STEAM TRAPS

How Different Condensing Rates Can Slow Production

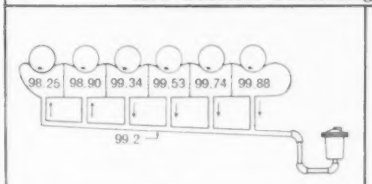


Fig. 1 This is a 6-roll ironer shortly after it has begun operating on 100 psi steam. When cold, wet material passes over chest 1, steam condensing rate is high and pressure drops accordingly. The pressure drop in chest 2 will not be as great, and so on down the machine as the material becomes progressively hotter and drier. Average pressure in the chests then is 99.27 lbs., and drain header pressure is slightly less, about 99.2 lbs. Under these conditions, steam from drain header enters chests 1 and 2 (as indicated by arrows at side of drain lines) because of pressure difference. Though condensate from chests drains by gravity, air can't leave chests countercurrent to incoming steam. Fig. 2 shows what happens next.

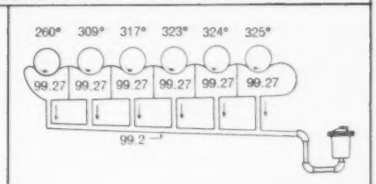


Fig. 2 This is the same 6-roll ironer after it has been operating a while. Air has accumulated in chests 1 and 2, reducing condensing rate and decreasing pressure drop. This process repeats itself down the line until pressures are as shown—that is, enough air will accumulate in each chest so that condensing rates and pressure drops of all chests will be about equal. The net result is shown in chest temperatures which are actual pyrometer readings taken on a 6-roll ironer, drained by a master trap, in a Chicago laundry. The laundry was making 337.9°F steam, but getting an average of only 309.6°F from the ironing surfaces, necessitating slow operation and frequent reruns. Then they tried Armstrong unit trapping—see Fig 3.

How Unit Trapping Prevents Trouble

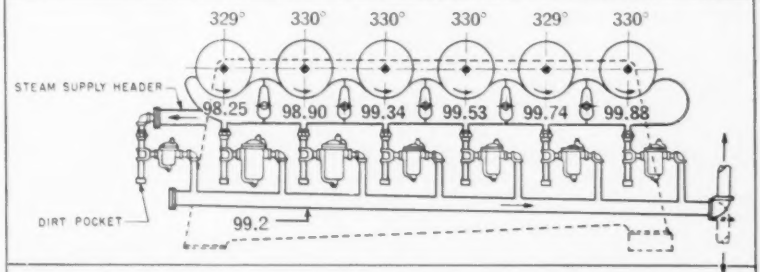
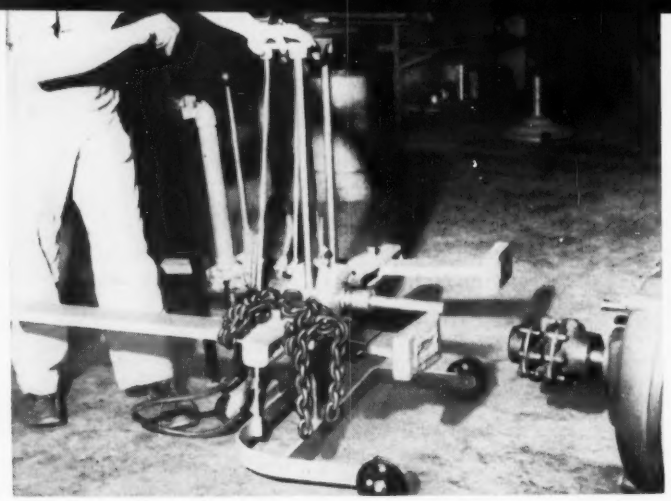
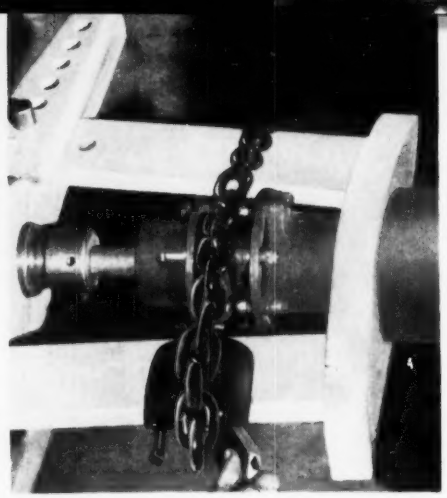


Fig. 3 This is the same 6-roll ironer, now unit trapped. Temperatures shown are also actual pyrometer readings—the average of 329.6°F is 20° higher than with group trapping. This is because air is continually removed from each chest into the drain header, and cannot get back into any chest.



1 Move puller toward motor coupling. Then use crank on puller to raise or lower the working mechanism so it is in line with the pulley to be removed



2 Use chain on puller arms to hold arms together. This keeps arms in back of object to be pulled

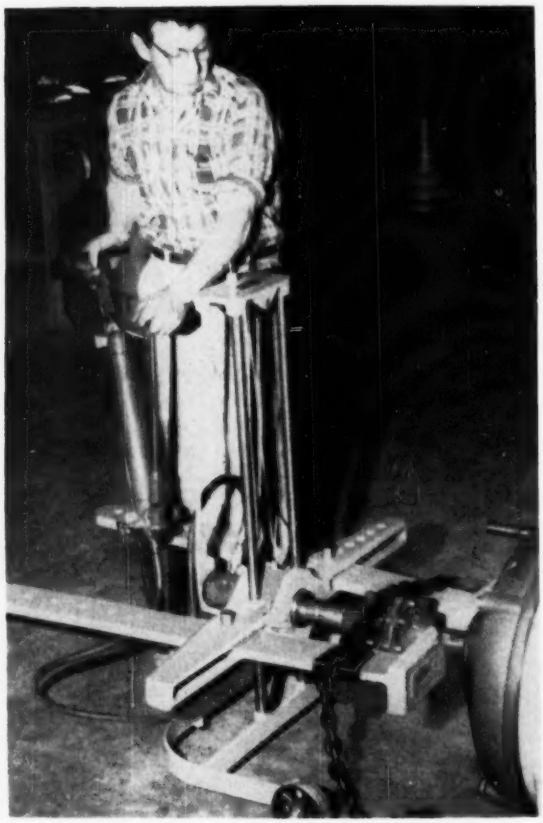
How to

use hydraulic puller

Now you can save time, labor and equipment with this all-round hydraulic pulley-puller. Designed for one-man operation, it removes almost any object from a shaft. Pressure is from hydraulic jack, operated by hand pump. Three simple adjustments set the puller to the dimensions you need. The beam, arms, jack and pump can be removed from puller stand for overhead or special uses.

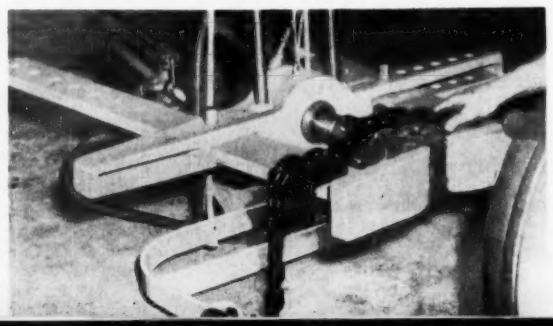
The puller is ideal for removing gears, pinions, pulleys, couplings, sheaves, bearing housings and other objects from shafts. Height and spread of puller is adjustable; it fits most needs. All-steel construction prevents parts from breaking; eliminates need for using crowbars and sledges. Operator needs only to adjust the puller and operate the pump.

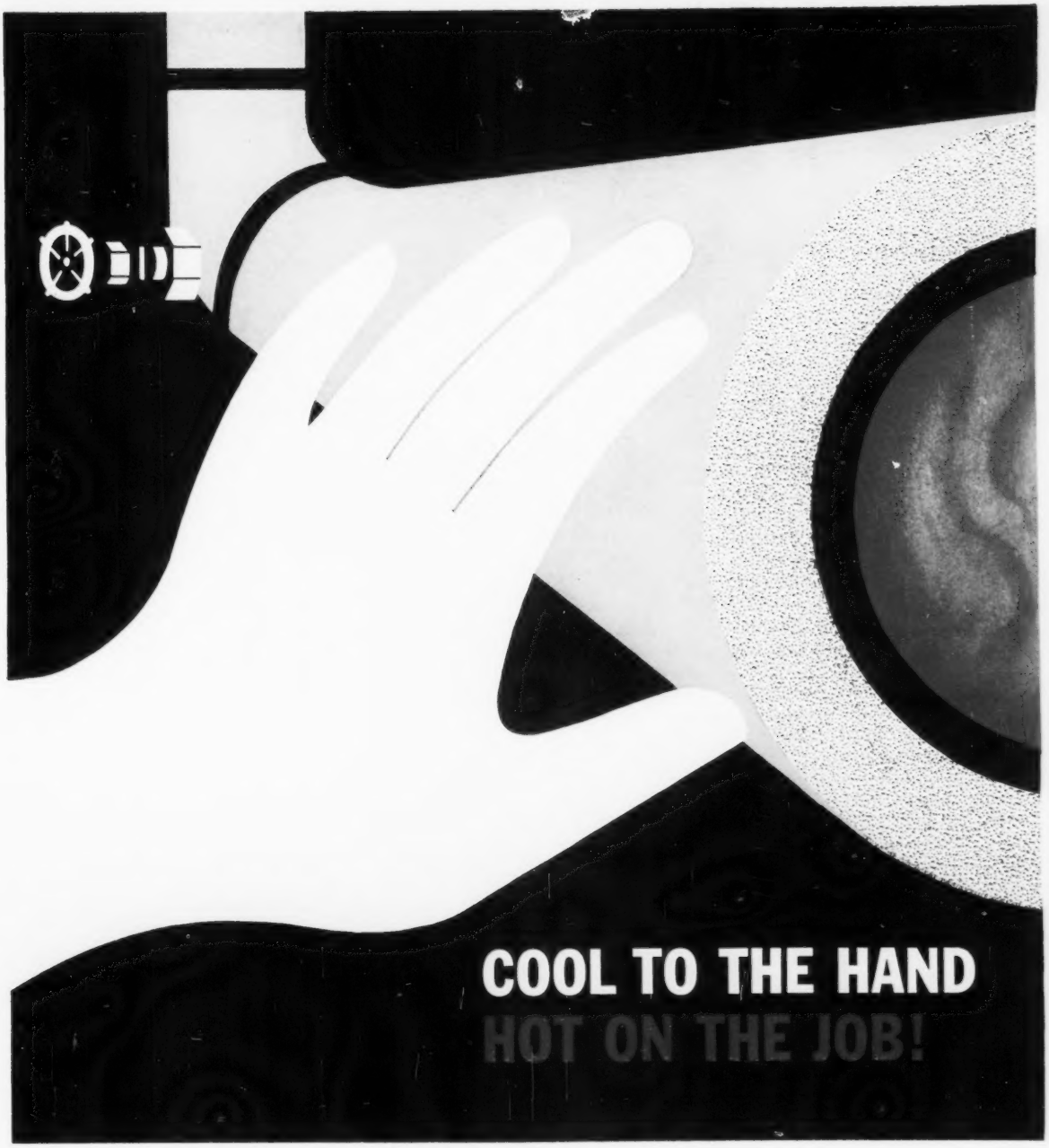
Unit is mounted on wheels, comes in 5, 20 or 50-ton pressure models. Special ram adapters can be obtained for the 20- and 50-ton models to handle shafts of almost any diameters. Special chain attachment is available for all three sizes to hold puller arms together.—*Courtesy, Industrial Engineering Equipment Co, Davenport, Iowa*



3 Operate the hydraulic pump to put pressure on the ram until the coupling comes off. This is a simple one-man job

4 Here, coupling is removed. Chain which held the arms together acts as holding mechanism for coupling just removed





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Basics . . . bringing engineering theory down to earth

NORMAN PEACH Assistant Editor

Electricity: 17

Here is what a transformer does

Transformers are ac devices that make use of the principle of mutual induction to raise or lower voltage. There is no electric conduction between the two windings of a transformer. They are connected only by magnetic flux passing between them. Input windings (connected to the power source) are called *primary windings*. Output windings (connected to the load) are called *secondary windings*. In a *stepdown* transformer the primary is high voltage, the secondary is low voltage. In *stepup* transformers, the primary is low, the secondary is high.

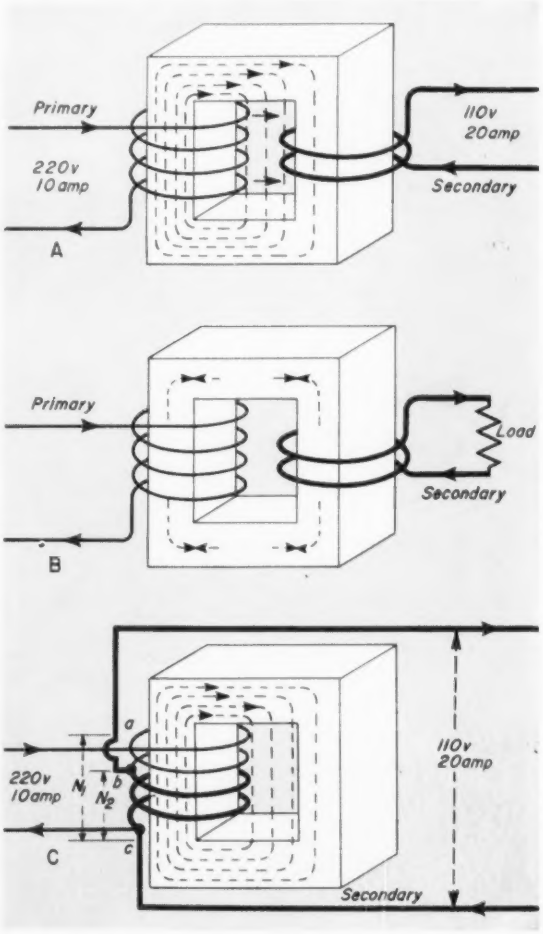
When there is current in the primary a magnetic flux is produced around it. This flux is proportional to current I and number of turns N, and inversely proportional to the reluctance of the magnetic circuit, as explained in *Basics No. 7*. A core made of magnetic steel is used to keep reluctance low. As the alternating current in the primary changes during each cycle, magnetic flux lines move outward from the primary core into the secondary core, cutting across the secondary coil and inducing a voltage in it, sketch *A*.

If the secondary circuit is open, all flux is produced by the primary, and the primary coil has a high reactance. High reactance keeps primary current low. But if the secondary circuit is closed, secondary current produces a flux of its own that opposes primary flux, sketch *B*. This, in effect, reduces primary reactance and more primary current flows. Transformers are thus self-governing; as secondary current (load) increases, primary current increases to supply power.

With reluctance constant and changes in secondary current compensated for by changes in primary current, ratio between voltages is proportional to ratio of turns. Considering sketch *A*,

$$\frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{2}{4} = \frac{110}{220}$$

Autotransformers have one winding instead of two. Primary and secondary leads have one common connection, point *c*, sketch *C*. Primary voltage is connected between *a* and *c*, and secondary voltage is obtained between *b* and *c*. Ratio of secondary voltage to primary voltage is the same as ratio of turns between *b* and *c* to turns between *a* and *c*. Action of autotransformer is complicated; for sake of simplicity it may be thought of as a voltage-dropping reactor. The magnetic flux cuts the turns of the coil inducing a voltage opposite to the applied voltage (the self-induction of the coil). Part of this voltage is "tapped" for the secondary. In sketch *C*, the 20-amp secondary current divides at point *c*, 10 amp going out as primary current, 10 amp flowing through the coil from *c* to *b*. Primary 10 amp flows from *a* to *b*. Secondary flux opposes primary flux, as in regular transformer. Stepup autotransformers have primary connected from *b* to *c*, take off secondary voltage between *a* and *c*.



Next month's Basics: Induction motors

JENKINS

O.S.&Y. U-BOLT GATE

MADE BETTER THAN NEED BE . . .

Costs Less to Use

YOU PAY NO MORE for the extra quality you see in every part of a Jenkins Outside Screw & Yoke U-Bolt Gate valve. Yet longer life and reduced maintenance is bound to result from the extra ruggedness, the precision manufacture and unique design features which Jenkins puts into these popular, general utility valves.

Choose the Outside Screw & Yoke pattern for services where spindle threads must be kept out of the destructive effects of fluids in the line; where spindle threads must be cleaned and lubricated regularly or where a rising spindle is needed to indicate wedge position.

Choose JENKINS, whether O.S. & Y. or Inside Screw pattern, for valves built to save maintenance dollars.

WIDE RANGE OF JENKINS U-BOLT GATES

GET FOLDER NO. 207 which describes Inside Screw and O.S. & Y. patterns . . . Iron Body with Bronze or Stainless Steel Mounting . . . All-Iron and Ni-Resist with type 316 Stainless Steel trim. Ask your local Jenkins Distributor or write Jenkins Bros., 100 Park Avenue, New York 17.

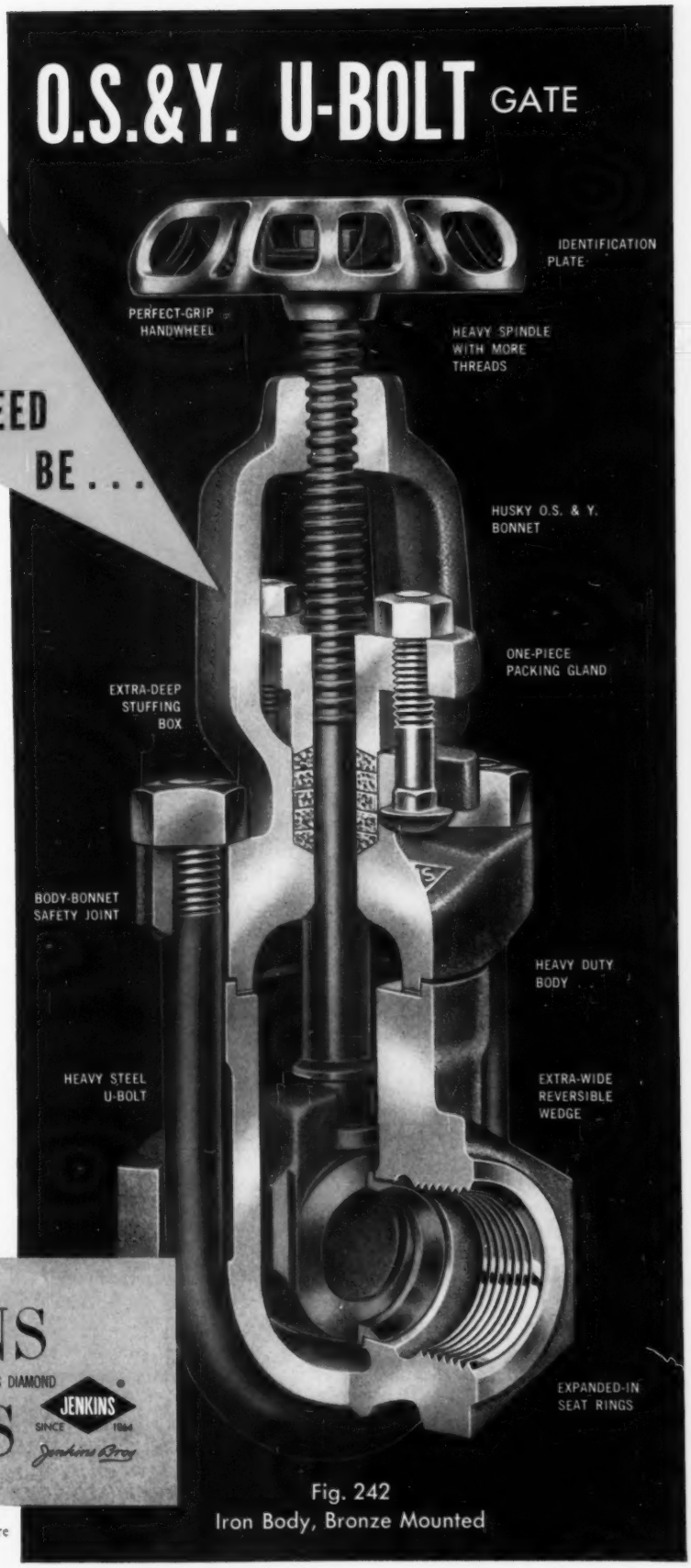
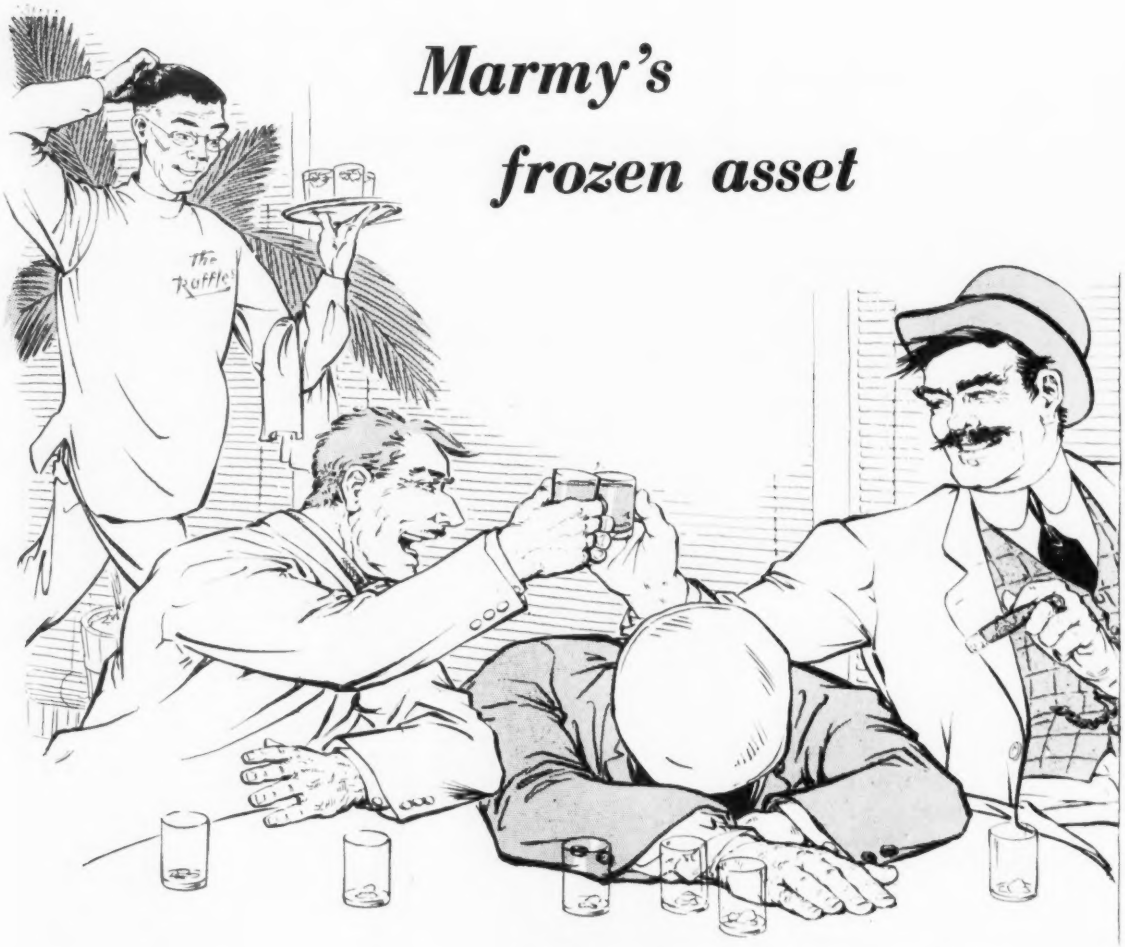


Fig. 242
Iron Body, Bronze Mounted

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS SINCE 1864 Jenkins Bros.

Sold Through Leading Distributors Everywhere

Marmy's frozen asset



"The cold gin slings sure hit the spot. We emptied our glasses and then split Snifty's between us," roared Marmaduke

Dropped into the Bent Propeller Bar one day last July, hoping I'd run into Marmaduke Surfaceblow. When I asked his old shipmate Bedlam about him, he asked, kind of surprised like, "Don't you know Marmy spends his time at his summer address?"

"Summer address?" I echoed, wondering if I had gone batty. "No, I always thought the foxy old buzzard had a roll of dough salted away, but I didn't know he was that well off."

"Well, now," said Bedlam, putting heads on a few tall beers for some Dutch seamen lined up along the bar, "you just go down to Battery Park. His summer address is Bench No. 3, next to the Staten Island ferry."

Bedlam was right. Bernard Baruch might be the autocrat of the Central Park Bench Warmers Association, but Marmaduke sure is king-pin in Battery Park. There he was, sitting on his bench, surrounded by an assortment of salty-looking characters in shirt sleeves, with tattooed arms and weather-beaten faces.

Marmaduke was in shirt sleeves too, but the old gray bowler was still cocked at an angle on his massive head. With sea gulls calling mournfully overhead, tug- and ferryboat whistles shrieking nearby and ocean-going ships moving about in the harbor, old cantankerous Surfaceblow was in all his glory.

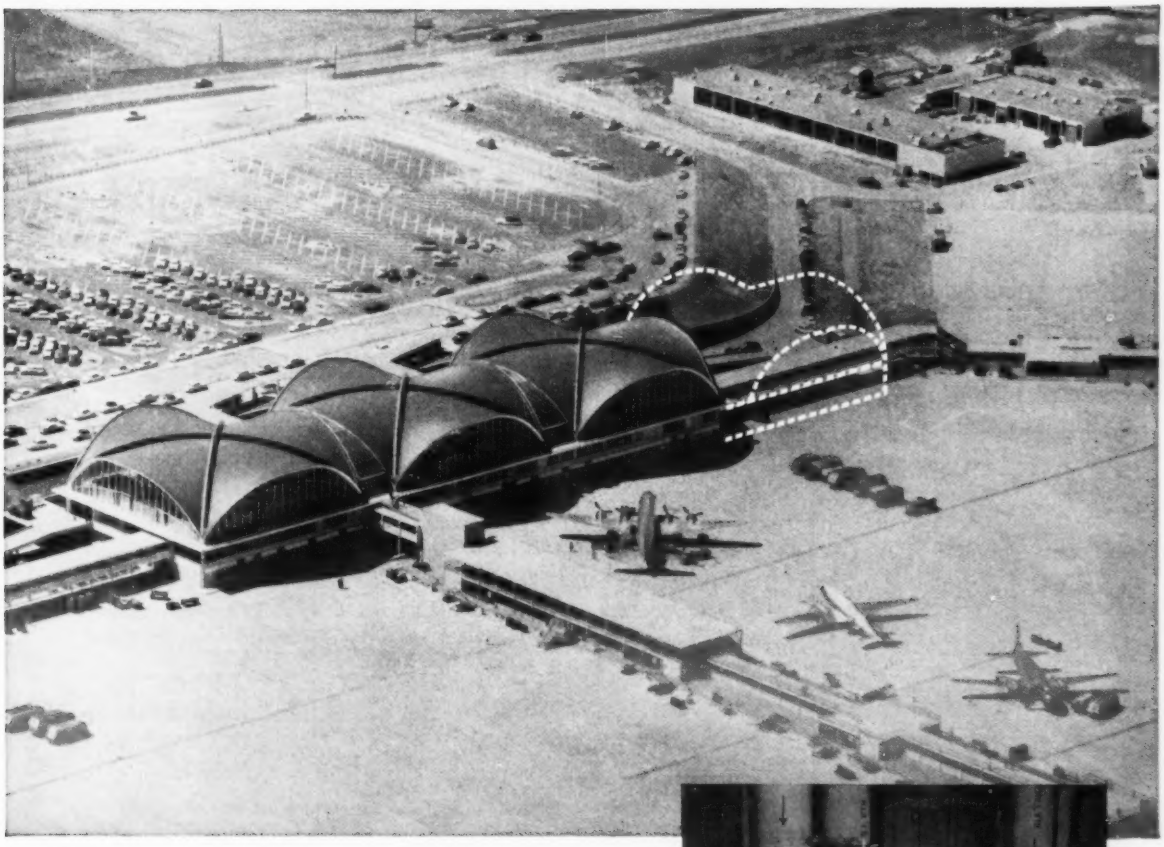
I said, "Hello Mr Surfaceblow," but no one gave me a tumble. For the time being, they seemed deeply interested in a rusty freighter plowing up the bay past Ellis Island. Some were squinting their eyes in an effort to make her out.

"It's the old *SS City of Penang*," said a long, thin skeleton of a seaman sitting next to Surfaceblow. "She's coming in from Karachi."

Marmaduke wiped the sweat from his brow with a large red bandanna —then suddenly exclaimed, "The *City of Penang!* Why, that's the tub old Snifty McSpadden kicked the bucket on back in 1909—may his poor soul rest in peace."

"Snifty McSpadden," Marmaduke rasped, "was the freezer and I was third assistant on the *Penang* in those days. Snifty always kept a bottle of Sandpaper Gin in the evaporator room on top of the frozen coils. Every time he went inside to check the brine return temperatures, he took a snifter—and that brine sure got a lot of checking!

"Pulling out of Hong Kong one trip, Snifty was full of gin as usual and couldn't hold his cargobox temperatures (*Continued on page* 168)



Top photo: Unusual modern architecture of St. Louis Municipal Airport Terminal Building is expandable in any direction. New units (dotted lines), can be added readily when required. Services buildings, *upper right*, are built and equipped with future expansion in mind. *Photo by Lloyd Spainhower.*

Lower photo: Nalco Chemicals and Services protect both boiler and cooling water systems at new St. Louis Airport. In this photo a Nalco cooling water treatment, supplied in ball briquette form, is being applied through the convenient Nalco feeder.

Nalco protects vital services of new LAMBERT-ST. LOUIS AIRPORT

Functional efficiency is usually one of the hallmarks of fine architecture and it is apparent throughout the new St. Louis Municipal Airport Terminal Buildings.

Vital service facilities are housed in a low, clean-lined power plant, well separated from the present main terminal building in anticipation of planned expansion to accommodate increasing airline traffic. The Nalco System protects boiler and cooling water systems by effectively controlling scale, corrosion and microbiological growth . . . a non-architectural supplement to functional efficiency in *any* plant where water is used.

Whether you are planning a new plant, or modernizing an old one, call on Nalco for water treatment chemicals and services that consistently produce outstanding results.

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Reader service section

Start with these quick samples...

Scanning the skies . . .

job 24 hours a day. Read more about them in . . .
installations all over the country, supersonic speed trackers and computers form a humming, blinking, glowing maze. The power behind this watchdog equipment is supplied by diesel engine-generators, on the job 24 hours a day. Read more about them in

Reports from the field, p 150

The changing times . . .

bring new methods, and scads of new technical reports each month to be read and noted. To speed up the process, we've made a selection of the latest papers, digested them, and now present them for your reading convenience. If you want to go deeper into any subject, there's complete info on how to get the full report.

Technical briefs, p 152

Frustration . . .

is a mild word to describe the feelings of the plant engineer plagued by coal hangup in bins and bunkers. Beating the stuffing out of the offending bin with a sledge may relieve his feelings, but we have a better solution—pulsating panels, built right into the bin, that keep the coal moving. This and other products in . . .

Plant equipment news, p 156

The man with the oilcan . . .

is on our mind this month. We've listed five of the latest trade bulletins on lubricants, three dozen others on welding, water treatment and what-have-you. Write the key numbers of the brochures you'd like to receive on one of the cards we provide, send it to us, and we'll see to it that the postman keeps your mailbox filled.

Free literature, p 163

Pocket-sized charm school . . .

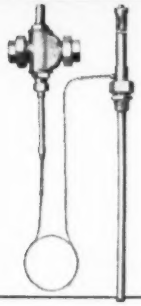
is an interesting idea. George Edwards knows a man who has a pocket-sized school, or at any rate, a rule—that's won and kept him a lot of friends. It has something to do with three monkeys, and more than a little to do with good, common horse-sense. For an up-to-the-minute application of a time-tested rule, check with . . .

George Edwards, p 166

For other timely ideas, see following service pages▶

Low-cost Temperature Control — by SARCO

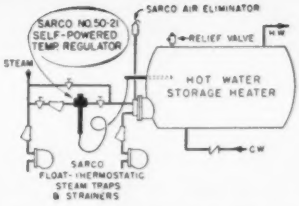
Self-Powered and Electric Indicating



Sarco Temperature Controllers Self-Powered . . . Fully Modulating

Simple as ABC . . . a thermostat with capillary tubing and a valve. That's all! Operated by liquid expansion. Automatic. Self-powered . . . no electricity or compressed air required. Self-contained . . . no exposed mechanism. Packless valve . . . no stuffing box to leak or stick. Easy to install by any pipefitter.

Furnished with thermostats suitable for any liquid or for air in dryers, ovens, air ducts, etc. Valve sizes . . . ½ to 6". Temperature ranges to 300°F. *Bulletin 620-2.*

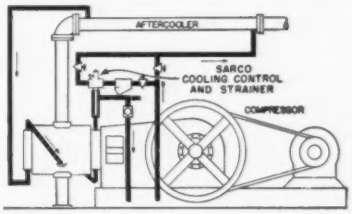


Typical applications: Shell and tube heat exchangers; condensers, oil storage tanks, dryers, etc.

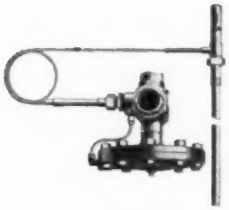
Sarco Cooling Controls Self-Powered . . . Fully Modulating

Simple, compact, automatic thermostatic valve. Eliminates overcooling and undercooling. Saves water. Overall height of ¾" size is only 17 5/16". Self-powered . . . requires no electrical or compressed air hook-up. Valve and bulb all in one unit. No exposed mechanism. Single-seated packless valve . . . not affected by silt or scale-forming minerals.

Valve sizes . . . ⅜ to 1½". Temperature ranges between 40° and 210°F. *Bulletin No. 710-B.*



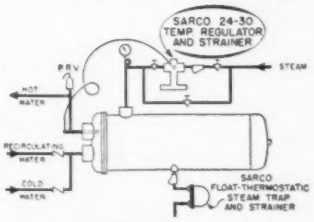
Typical applications: compressors, small engines, water-cooled bearings, condensers, dry cleaning stills, etc.



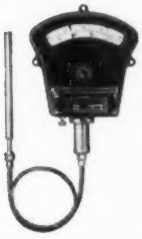
Sarco Temperature Controllers Self-Powered . . . Single-Seated, Tight-Closing

A simple, self-powered automatic temperature controller with diaphragm-operated, pilot-controlled valve. Designed for intermittent service or service involving long periods with practically no call for steam. Self-powered by liquid expansion . . . no electricity or compressed air needed. Packless.

Valve sizes . . . ½ to 3". Temperature ranges to 300°F. *Bulletin No. 625-B.*



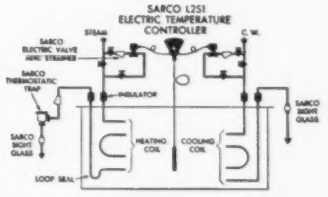
Typical applications: instantaneous heaters, fuel oil pre-heaters, high pressure applications on hot water storage tanks.



Sarco Electric Temperature Controllers Indicating Type

Simple, inexpensive, electric-indicating automatic temperature controller. Sensitive enough to perform many of the functions of much more elaborate recorder-controllers, at a fraction of their cost. Responds to changes of ± ½°F. Adjustable. Large, easy-to-read scale shows both actual and set temperatures.

Temperature ranges between minus 90° and plus 650°F. Offers many sequence combinations such as step-heating. *Bulletin 1025-B.*



Typical applications: plating tanks, processing vats, kettles, chemical tanks, etc.

Sarcostat Hydraulic Motor Valves Electrically Operated

For remote control by hand or thermostat. Open and shut operation. Can be equipped with semi-modulating mechanism. Powerful hydraulic action operates valves up to 5" single-seated, or 8" double-seated, at pressures up to 175 psi. Ruggedly constructed . . . to withstand severe use without constant supervision and with minimum maintenance. Operates in any position.

For direct connection to 110 volts A. C., 60 cycle current. Valve sizes . . . ½ to 5" single-seated; ½ to 6" double-seated. *Bulletin 1080-A.*

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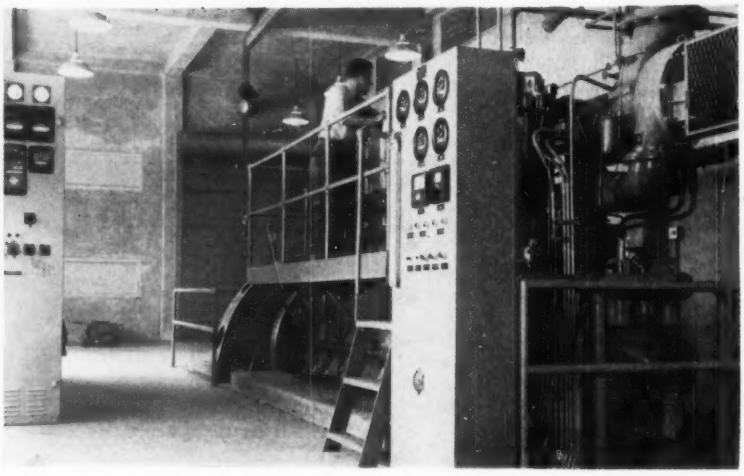
2230-B

Write for Bulletins to — **Sarco Co., Inc., 635 Madison Ave., New York 22, N. Y.**

Reports from the field

What's happening in power and what it means to you

For Calendar of Events see page 212



Diesels keep 'em in the air—or out of it

Complete protection against power failure at San Francisco's International Airport is provided by 1000-kw 4160-v fully automatic generator powered by Enterprise DSG-318 diesel engine, above, rated 1412 bhp at 600 rpm. Unit's main duties are to restore power immediately for field and essential building lighting, and for drainage pumps in case of flood conditions, since airport is located on 3000 acres reclaimed from tidelands. Diesel engine can automatically start, connect to station power bus and develop at least ¼ of rated output at rated frequency within 15 sec from instant of power failure; assume full load within 5 min; provide continuous full-load operation without shutdown for weeks or months if necessary.

In a different application, diesel generators power SAGE (Semi-Automatic Ground Environment) stations searching the skies for signs of possible enemy planes. Each observation post in continental set-up has its independent power source: six engine-generator units with capacity safety factor of 2.5 to assure adequate power for tracking, computing equipment. Operation of each engine is monitored by alarms which sound a warning in case of trouble, start up replacement engines automatically. Nordberg in-line supercharged diesel engines have six cylinders of 13-in. bore, 16½-in. stroke, are rated 930 hp at 450 rpm. Electric Products Co generators produce 650 kw of 480-v 3-phase 60-cycle alternating current.

Electricity's booming; check these figures

Generation by the electric industry totaled 636 billion kwhr in 1957, an increase of 35 billion over 1956 according to Edison Electric Institute. Sales reached 561 billion kwhr. Including industrial and railway production, total generation was 721 billion kwhr. Largest construction program ever undertaken will begin in 1958, including scheduling of 16.25 million kw of new generating capacity. At the end of 1957, 100 electric utility companies were engaged in nuclear research, 60 participating in planning of 13 nuclear plants, of which three were essentially completed and four were under construction.

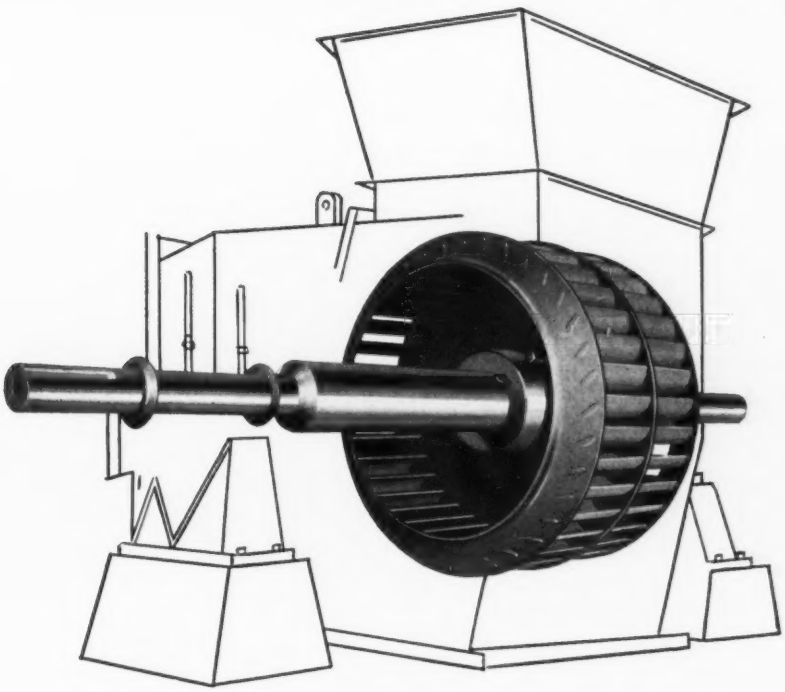
Power lines

February 9-15 is National Electrical Week, an all-industry annual observance held the week of February 11, Thomas Alva Edison's birthday. Principle is to focus attention on contributions of electricity to our economy and way of life. Endorsed by 26 electrical trade associations, observance activities include educational programs, plant tours, radio, TV and newspaper publicity.

Planning your retirement is the topic of a group of booklets published by U.S. government. Pamphlets discuss Social Security, health, hobbies, vacations and travel. List available from Superintendent of Documents, Govt Printing Office, Washington 25, D.C.; prices from 5¢ to $2.

Free nationwide consulting service is now available to businesses, industries and associations interested in developing libraries or information centers. Over 5000 librarians and subject specialists offer expert advice on need, cost and equipment problems. Those interested may write direct to Special Libraries Assn headquarters, 31 E 10th St, New York, N. Y.

Niels Bohr, a Danish physicist, is winner of the first Atoms for Peace award. In 1913, at the age of 28, Prof Bohr developed a concept which opened a new era in atomic research. His Institute for Theoretical Physics at Copenhagen is proof that "the domain of science and the domain of the humanities are in reality a single realm." Award totals $75,000.



CLARAGE TYPE DN DYNACURVE FAN OFFERS A

New Concept

IN INDUCED DRAFT WHEEL DESIGN

36 radially deep, aerodynamically curved blades impart a dynamic energy to the gas stream to achieve low tip speed operation.

Unique shape of the blades and rims minimizes shock losses and turbulence at the entering edge of the blades and between the blades.

Wheel design assures relatively low moment of inertia (WR^2).

Wheel is constructed with a heavy forged steel hub and a sturdy centerplate.

All welded construction of the wheel provides ample shear strength, tensile strength, and rigidity.

These are only a few of the features that make Clarage's new Type DN Dynacurve Fans fully equal to the most punishing demands.

Write today for Bulletin 905. CLARAGE FAN COMPANY, Kalamazoo, Michigan.

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Technical briefs

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8 papers for you on:

POWER GENERATION
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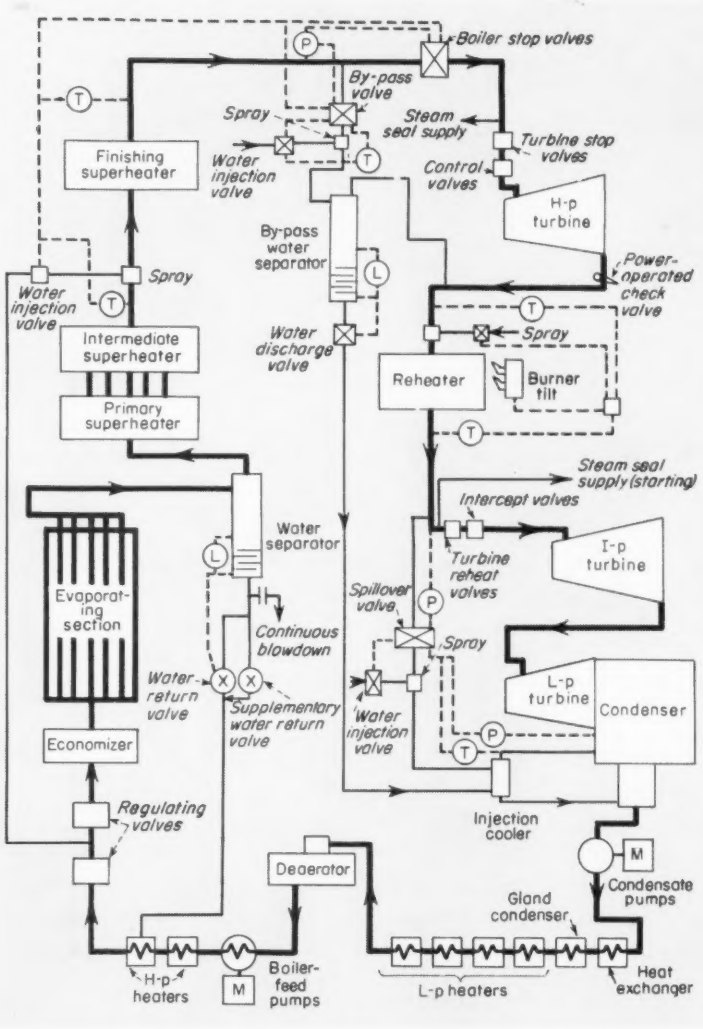


FLOW DIAGRAM shows monotube boiler, cross-compound axial-flow exhaust turbine

New station has unusual features

Axial-flow exhaust turbine and monotube boiler are basic design considerations of Portland Generating Stations. *By J G Miller, Metropolitan Edison Co and R H Kreisinger, Gilbert Associates, Inc*

This paper is one of four describing development of the Portland Generating Station of Metropolitan Edison Co at Portland, Pa. It describes overall station design, showing the effect on a new station designed to incorporate both a monotube boiler and an axial-flow exhaust turbine.

First unit at Portland includes a monotube boiler (new in this country); a new turbine design (close-coupled cross-compound axial-flow exhaust turbine); a new turbine-condenser arrangement (single-cylinder low-pressure turbine has the same center line as the condenser); and a combustion control which involves a new concept (direct energy balance method). Even so, the authors do not expect total cost to be appreciably different than if conventional present-day design with the same steam conditions (2400-psi nominal pressure, 1050-F initial and 1050-F reheat temperature) had been followed. The estimated total cost, including land and substation, is $25,902,000—$157 per kw based on 165,000-kw capacity.

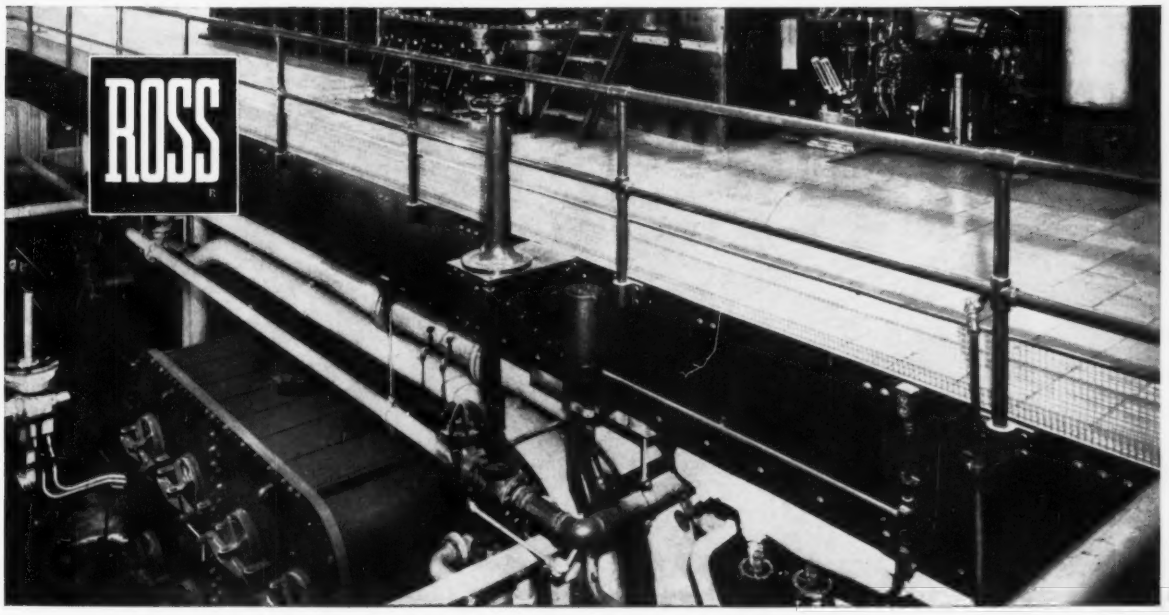
While they expect problems in the initial start-up, they do not feel that the problems will be particularly unusual or more complicated than if conventional equipment were used. *ASME paper, No. 57-PWR-3*

Design features and development of the cross-compound single-flow tubine with axial exhaust for Portland Station. *By J E Fowler and C Matney, General Electric Co*

Cross-compound design presents several possibilities in arrangement of components for improved performance and naturally leads to an opposed-flow, 3600-rpm, high-pressure single-span unit, in a machine of moderate capacity, in combination with the 1800-rpm low-pressure element. This type design permits a station layout that offers the designer new opportunities for reduction in building costs.

Use of a single-flow low-pressure element enables the turbine designer to incorporate an axial-discharge exhaust hood in which a significant portion of the kinetic energy in the exhaust can be recovered.

Discussion includes essential design features of a cross-compound turbine using steam from a monotube boiler and exhausting through an axial-flow exhaust hood to a mating



IN A SIDE-BY-SIDE COMPARISON...

"Ross Condenser brings turbine up to full load quicker"

On duty in a northwestern power plant, a Ross Surface Condenser is serving one of four identical 35,000 KW turbine-generator units.

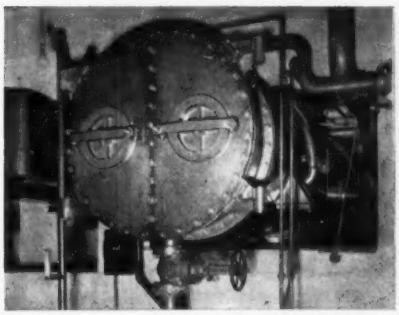
Although only one of the four condensers is a Ross unit (there are two other makes), the chief turbine engineer of this station singled it out for top performance: "The Ross Surface Condenser can bring the turbine up to full load quicker than any of the other condensers in this plant. It has been performing satisfactorily for 25 years. Our operators are well satisfied."

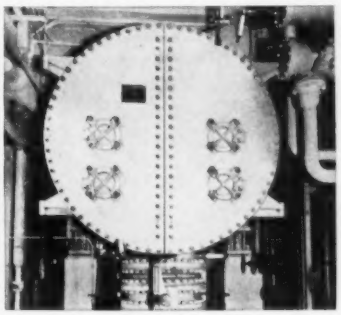
This is just one instance—there are numerous others (a few are also shown here) where Ross Condensers have clearly demonstrated superior efficiency and dependability. And this is not surprising. For over 40 years, Ross has set the pace in the design and construction of heat exchange equipment, by continually stressing advanced engineering . . . engineering that introduced the first all-welded steel surface condenser in the United States, and pioneered numerous other developments, including Balanced Flow and divided tube bank design.

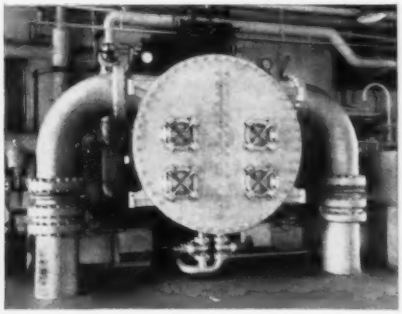
It's only logical then, that Ross is uniquely qualified to meet your surface condenser requirements. Consultation with Ross engineers will leave you assured of this.

For detailed information on Ross Twin Bank Condensers, or the smaller, Single Bank Type, request Bulletins 8.2K1 and 8.1K1 respectively.

American-Standard, Ross Heat Exchanger Division, Buffalo 5, N.Y. In Canada: American-Standard Products (Canada) Limited, Station D, Toronto, Ont.

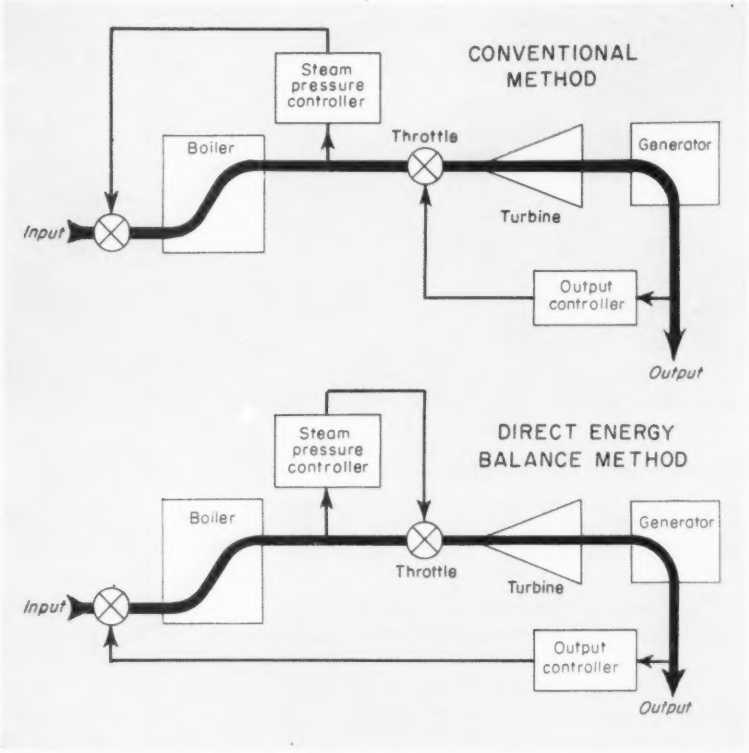






AMERICAN-Standard

ROSS HEAT EXCHANGER DIVISION



COMBUSTION CONTROL system for Portland Station features both methods shown

condenser arrangement. The authors describe the evolution of the axial-flow exhaust hood and show test results, with the expected improvement in overall operating economy. First boiler - turbine - condenser arrangement of this type will be installed in Portland Station. *ASME paper, No. 57-PWR-6*

Unusual features of the Portland combustion control system. *By E D Scutt, Leeds & Northrup Co*

Unusual features of the combustion control for Portland can be summarized as follows: (1) Two basic methods of operation are provided, namely the "direct energy balance" and the "conventional" methods. (2) A boiler-turbine governor component integrates operation of the boiler and turbine as a unit and keeps the output within the capabilities of the auxiliary equipment in service. (3) The steam flow measurement normally found in conventional combustion control systems has been replaced by electrical generator output. (4) Final adjustment of air flow is automatically controlled from oxygen to maintain optimum combustion.

The author concludes that the combustion control system for Portland Station employs new concepts for co-ordinating operation of the boiler and turbine as a unit. Final combustion conditions are automatically controlled from oxygen. This new control approach is currently being tested at Titus Station.

The close correlation between actual field operation and the computer simulation studies for Titus and other recent boiler installations has been most gratifying. Use of computer simulation techniques should greatly reduce the necessary time for field adjustment of control systems in the future and will aid in securing improved control operation. *ASME paper, No. 57-PWR-8*

The condenser at Portland. *By G T Jones, Ingersoll-Rand Co*

The condenser at Portland Station is more than the usual concept of an apparatus for heat transfer designed to produce a desired turbine backpressure.

Here are some of the requirements it has to meet:

This condenser must use all the proven fundamentals important to efficient heat-transfer performance and be aerodynamically suitable to the axial-flow exhaust turbine. It needs (1) a divided cooling-water circuit so the tubes can be cleaned without taking the turbine off the line (2) reversible water circuits for flushing away debris from the waterboxes and tube sheets. Water circuitry has to be compatible with the desired aerodynamic characteristics of the exhaust flow path. Air coolers within the condenser must be designed to accommodate this flexible water circuitry. Air removal equipment must be adequate at the lowest absolute pressures, so condenser can deaerate the condensate insofar as practical.

Condenser hotwell must reheat and contain in live storage a large quantity of condensate. Condenser must be able to handle large dump steam flows without allowing excessive heating of turbine exhaust blading and hood. It must be flexibly supported at the same elevation as turbine while bolted rigidly to turbine exhaust flange.

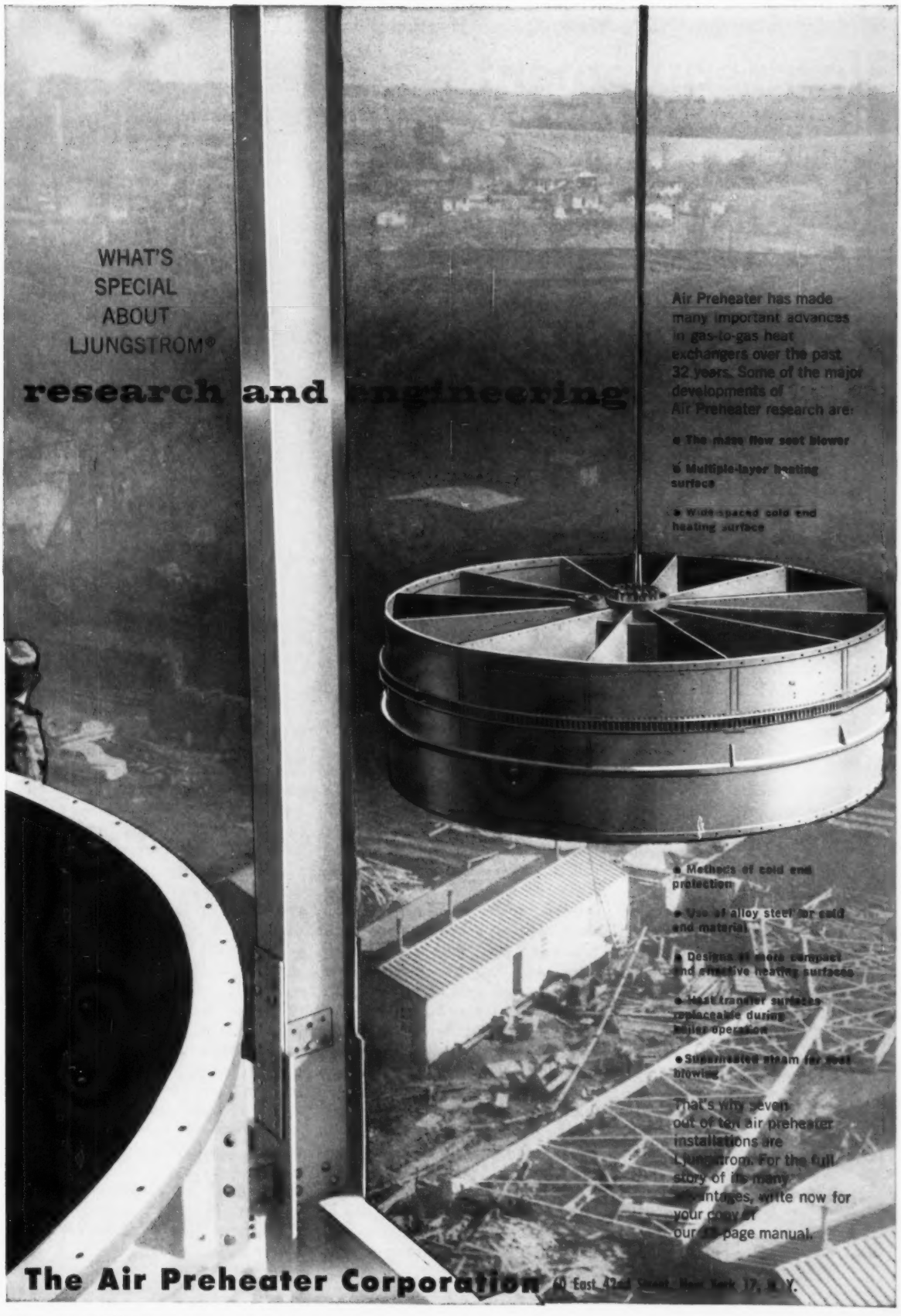
These requirements led to a new and unique condenser design. The paper gives you a look at this design and at what it promises. *ASME paper, No. 57-PWR-14*

Atomic power

Nuclear power trends. *By W T Moore, The Babcock & Wilcox Co*

Reactor types which author believes show promise for use in large central-station plants in the U.S. include: (*Continued on page* 190)

Directions for ordering papers on page 194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That's why seven out of ten air preheater installations are Ljungstrom. For the full story of its many advantages, write now for your copy of our 32-page manual.
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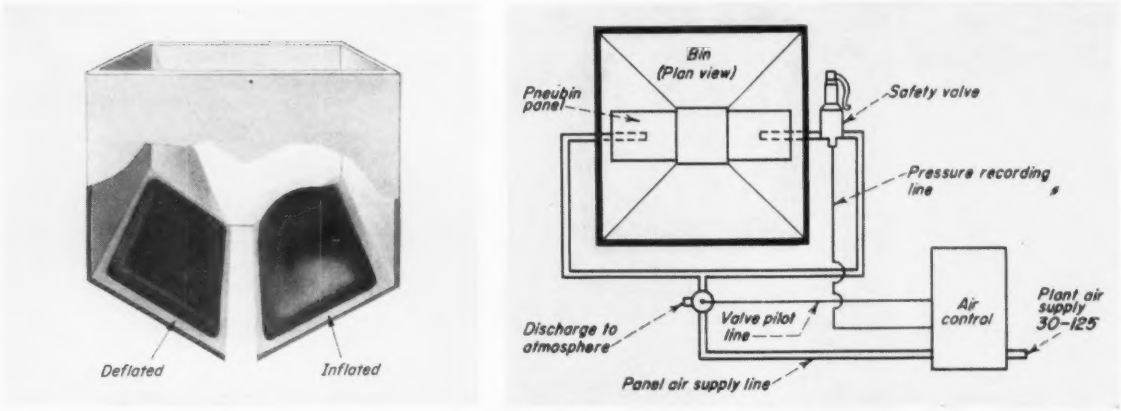
Plant equipment news

Your information center for new products and materials



TOUGH NEOPRENE PANELS, *left,* bulge into bin, cave in a bridge or rat-hole, extrude pasty material or break up caked material. Typical installation, *right,* tied in to plant air supply, is ready to attack flow stoppage at a moment's notice

Pulsating panels keep your bulk materials moving

101 • *PneuBin* inflatable panels are said to provide dependable, safe way of moving stubborn bulk materials from bins and hoppers. Pulsating panels are spotted at strategic points in bins and bunkers. Panels inflate and deflate at predetermined frequency and amplitude. Tied in to plant's air supply, units can be ready to go at a moment's notice, according to manufacturer.

Panel consists of a rectangular steel plate covered with elastic neoprene diaphragm. Lying flat against one side of plate, the diaphragm is wrapped around edges of plate and bonded to it on the back. Unit is bolted to inside of new or existing bin or bunker. Air is alternately admitted to and exhausted from the space between steel plate and neoprene diaphragm, causing diaphragm to inflate and deflate rapidly. Neoprene is thick and tough enough to withstand severe abrasive service, maker claims; also has high resistance to attack by corrosive materials such as coal.

When flow stoppage occurs in a bin or bunker, it's usually because material has bridged, formed a rat-hole down the middle (funneling), caked or is simply too viscous to flow. Panel works to correct these situations. In case of bridging, panels inflate to compress ends of the arch. Panel deflation leaves ends without support and they collapse. With a rat-hole, panels push material into the middle where hole is forming. With a caking problem, there's sufficient displacement by panels to break up big lumps and grind little ones against each other until they're small enough to drop through discharge opening. Panel movement will extrude material that's too viscous to flow freely.

Units are said to operate quietly, use confined air that can't stir up dust, have no tendency to produce segregation. Stirring action may even help prevent segregation, according to manufacturer.

Air-control assembly takes plant air at 30 to 125 psi and delivers it to panel. A pressure cut-off switch, with minimum and maximum settings of 0.5 and 5 psi respectively, controls amplitude (measured ballooning height of diaphragm). Depending on panel size, diaphragm amplitude ranges from one to nine in. Adjustable flow-rate throttle valve controls inflation frequency, which may range from one pulsation every two or three min to eight or ten pulsations per min. Panels can be used singly, in unison or in sequence through one controller. For example, two banks of panels located on opposite sides of discharge opening could be set to inflate alternately, thus shifting coal back and forth over the opening.

Though maximum operating air pressure is only 5 psi, panel's total exerted force is high. Total force exerted by 24 x 72 in. panel would be over 4 tons; displacement 6 cu ft of material per pulsation.

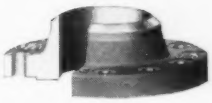
PneuBin units operate at temperatures to 150 F. They're suitable for pyramidal, conical or cylindrical bins and hoppers, in industrial and utility company power plants. — *PneuBin Div, Gerotor May Corp, Box 86, Baltimore 3, Md.*

For more data on these items, use the post cards on page 163. Identify your request with item number

90° butt-welding elbow—Crane offers 16 different butt-welding fittings—½" to 24" for all pipe strengths.

Socket-welding tee—The Crane line of socket-welding fittings includes 9 different types for sizes ⅛" to 4"; 2000, 3000, 4000, 6000 lb. W. O. G.—non-shock—temps. 100° to 1000° F.

Crane butt-welding globe valve—The Crane butt- and socket-welding end valve lines include bolted bonnet, lip-seal, pressure-seal and union bonnet valves in a variety of globe, gate, angle and check designs.



Forged steel welding-neck flange—One of 3 standard types of forged steel flanges available from Crane for welded piping.

Send for this NEW Crane Circular of Welding Fittings, Flanges, Valves

A concise four-page guide to Crane's complete stocks of welding fittings, flanges and valves is available for your reference use. It provides you with a fast, accurate method of ordering *all* of your welding piping materials *from one source of supply.*

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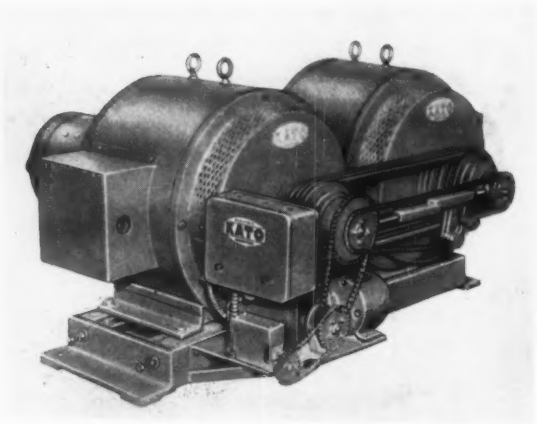
More **equipment news**

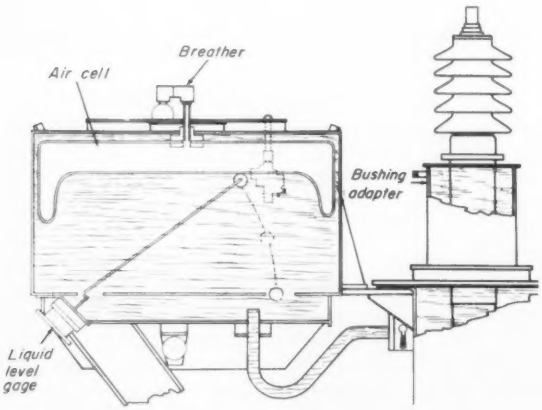
Begins on page 156



Pushbutton adjusts generator frequency

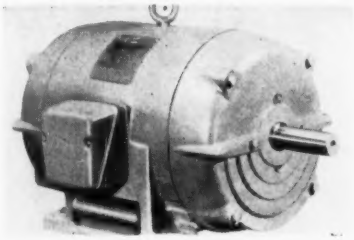
102 • Speed increase or decrease for 1200-rpm synchronous motor and 1200-rpm revolving field generator set is accomplished by pushing "fast" or "slow" button. Reduction-gear motor provides power to alter pitch of variable pulleys on motor and generator. Generator speed is 1030 rpm for 360 cps, 1320 rpm for 440 cps.

Control equipment includes magnetic amplifier-type voltage regulator, synchronous motor starter, load limit switch and reset buttons. Unit is rated at 5 kw, 3 phase. —*Kato Engineering Co, Mankato, Minn.*



Transformers feature oil preservation

103 • Constant-pressure oil-preservation system is available on all power transformers above 10,000 kva. System is said to eliminate oil-to-gas contact and wide pressure variations, helping to prevent hazardous bubbles from developing in transformer oil. Feature of system is rubber air cell in expansion reservoir located beside transformer cover. As oil expands or contracts because of temperature change, nylon-impregnated Nitrile rubber cell adjusts to keep pressure constant.—*General Electric Co, Schenectady 5, N. Y.*



Synchronous-induction motors in 1 to 100-hp ratings

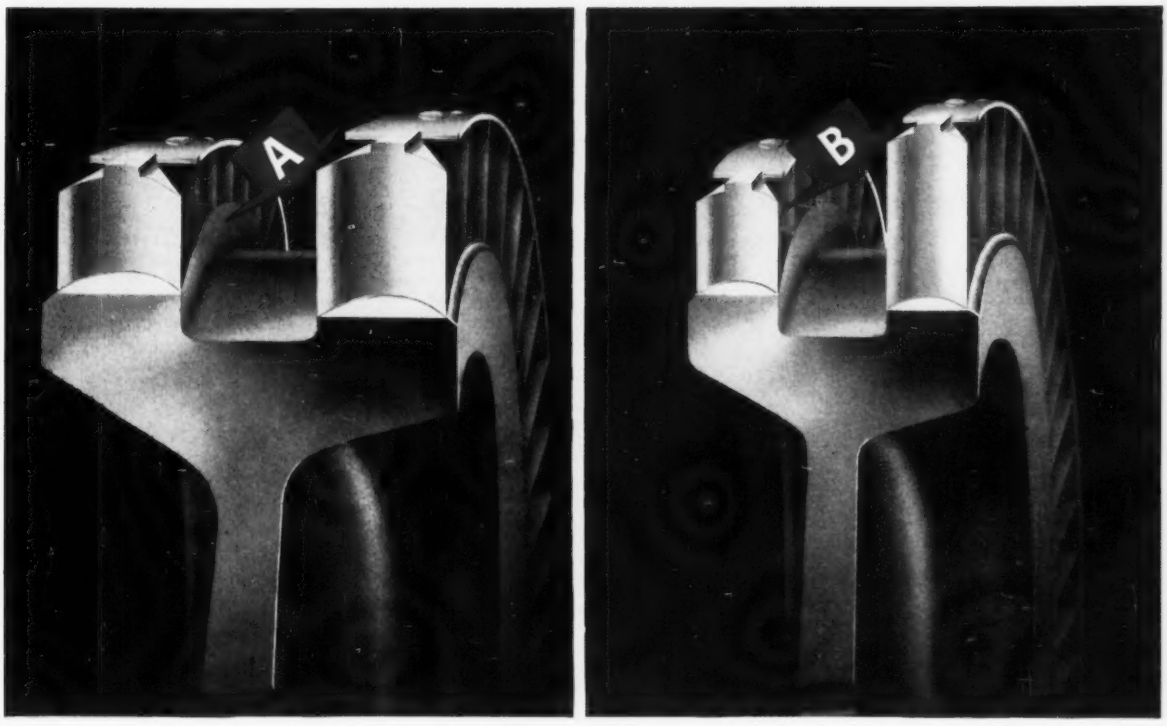
104 • Motors in 1- to 100-hp ratings are built in same NEMA frame size as standard motor of equal hp, manufacturer claims. Units are said to accelerate as induction motors, but run at exact synchronous speed without permanent magnets or dc excitation involving collector rings and brushes. They can be used to provide precise frequency systems in small generator ratings, and come in any enclosure type—foot or flange mounted.—*Louis Allis Co, 427 E Stewart St, Milwaukee 1, Wis.*

Silicon rectifier

105 • Unit is designed to permit utilities to continue serving dc customers while installing ac power. Rectifier is for street-vault installation, measures 83x45x85 in., gives 98% efficiency at full load according to manufacturer. Features are: silicon rectification, full wave bridge connected; 5% regulation with constant-line voltage; 4.5% ripple across outside legs; dc output of 120/240 v, 1000 amp, 3 wire; ac input of 208 v, 3 phase, 60 cycles, 4 wire; submersible construction; seam welded to withstand 7 psi.

Unit is constructed of ½ and 5/16 in. steel plate; has airtight fuse box, and is designed for continuous operation in ambient temperature of 50 C with standard-grade oil coolant. Construction includes transformer with tap switches for 2% voltage adjustment; multiple windings.—*Richardson-Allen Corp, 116-15 15th Ave, College Point, L. I., N. Y.*

For more details on these items, use post cards p 163. Identify your request with item number.



(Left, A) wide bucket "L" type wheel. (Right, B) regular type wheel for Coppus Steam Turbines

Now . . . for low steam consumption – **COPPUS TURBINES** *can be furnished with wide bucket "L" type wheel*

Good news for steam turbine users where low steam consumption is important!

The Coppus Type "L" Wheel is the answer to this problem. Larger turbine buckets are employed to make the most economical use of steam.

In every respect the Coppus Turbine offers the top-quality features and advantages that have made the Coppus line outstanding for efficiency and economy. For example:

- Turbines rated close to your exact hp requirements, from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.

Coppus Steam Turbines ranging from 150 hp down to fractional, in 6 frame sizes, *make turbine dollars go farther.* Send for Bulletin 135 on Coppus Turbine.

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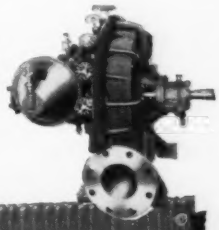
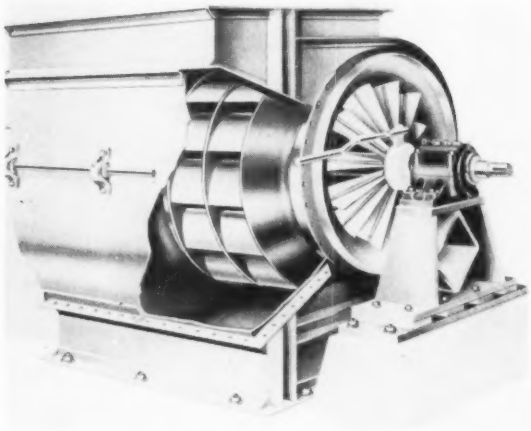


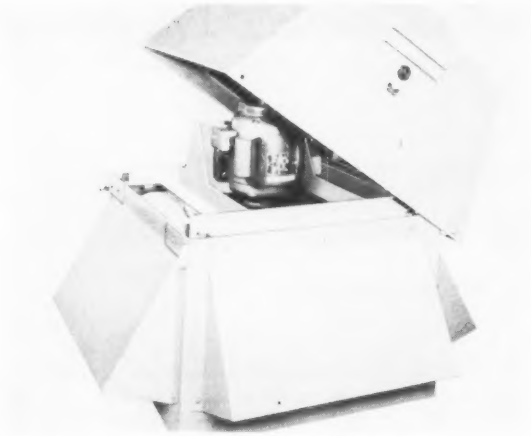
COPPUS "BLUE RIBBON" TURBINES



Forced-draft fan features airfoil wheel

106 • Designed for central power stations and heavy industrial service, unit is engineered around an airfoil backward-curved nonoverloading-type centrifugal wheel. Mechanical efficiencies to 92% are claimed by manufacturer. Hollow-section airfoil blades work on airplane-wing principle; smooth passage of air over blade surface eliminates eddy currents, lowering noise level 20 to 40% and requiring less hp, according to maker.

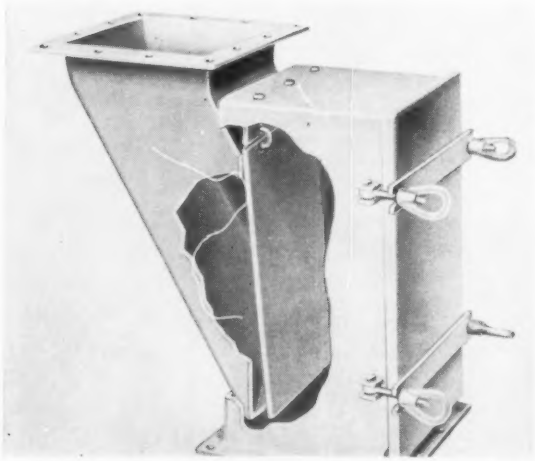
Fan is said to furnish static pressure from ¼ to 32 in. in volumes ranging up to 1,097,940 cfm; temperatures to 900 F. Inlet vane controls provide fan-output regulation. Housings are continuous-weld heavy-plate steel, come with flanged inlets and outlets.—*Chicago Blower Corp, 9863 Pacific Ave, Franklin Park, Ill.*



Centrifugal ventilator has direct drive

107 • Roof ventilator is available in various motor selections, including single phase, 115/230 v, 60 cycle; 3 phase, 220/440 v, 60 cycle. Comes in 1/10 to 10-hp sizes. Wheel diameters range from 12¼ to 36½ in., capacities are 1100 to 25,000 cfm.

Backward-curve wheels are dynamically balanced, taper locked to shaft. Venturi inlet is said to assure quietness and high efficiency, helping unit to operate with near-centrifugal blower characteristics. Units are weathertight, bird screen is standard equipment. Knockouts are provided for internal wiring. Unit has welded base with curb overlap, can be furnished in totally enclosed and explosionproof models.—*The Peerless Electric Co, Fan & Blower Div, 1500 W Market St, Warren, Ohio.*



Trickle valve maintains gas seal

108 • Unit, designated *Type FA*, provides continuous discharge of dust from cyclones and other dry dust collectors while maintaining positive gas seal, according to manufacturer. Patented ring-type hinge on valve plate is said to permit true alignment of surfaces which form gas seal, preventing bending, and giving continuous trouble-free performance under severe conditions of temperature, corrosion and abrasion.

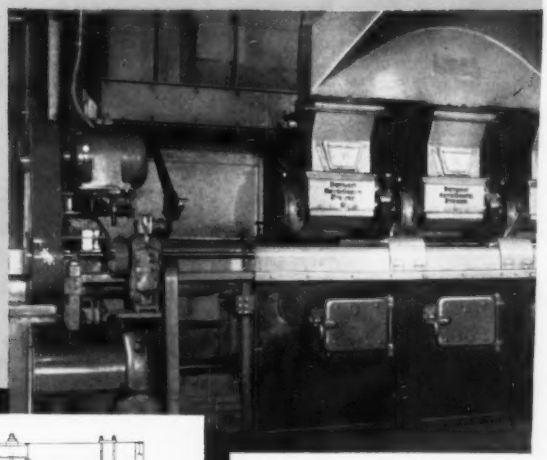
Front-access door opens all internal parts for inspection and observation. Door is fastened with four hinged eye-bolts which lock into open-end slots.

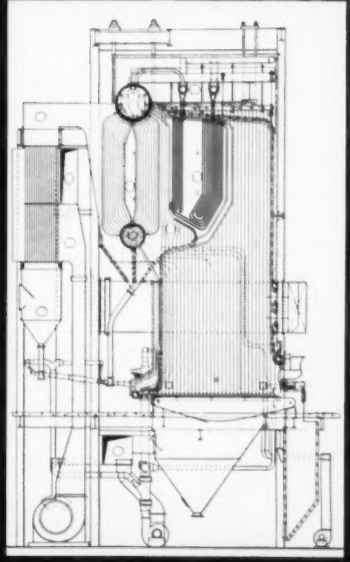
Unit is suitable for all free flowing materials with specific gravity of two or higher. The unit is applicable for negative pressures up to 12-in. water gage.—*The Ducon Co Inc, 147 E Second St, Mineola, N. Y.*

For more data on these items, use the post cards on page 163. Identify your request with item number

Mile High Plant Steam Generator Fired By DETROIT ROTOGRATE STOKER

Southern Colorado Power Co





Note — This information is out dated. Another Roto Grate is being added here, to fire a new 200,000# per hour unit.

This new unit which triples the capacity of the plant consists of a Babcock and Wilcox two-drum single pass steam generator fired by a Detroit RotoGrate Stoker having six feeders and distributors. The plant is at 5,300 feet above sea level. Capacity of above unit is 150,000 pounds of steam per hour at 660 psi, 915° steam temperature with preheated air at 350° F.

Design is based on bituminous coal:

B.T.U. per lb as fired	10,828
Moisture	8.84%
Volatile matter	33.72%
Fixed Carbon	44.69%
Ash	12.75%
Sulphur (separately determined)	0.7%

However, operation has been completely successful with coal from various mines in the vicinity.

Detroit RotoGrate is an exceptionally efficient spreader stoker with overlapping highly restricted grates that move slowly forward discharging ash at the front. Permits high burning rates with all Bituminous coals, Lignite or refuse fuels. *Write for Bulletin.*

Southern Colorado Power Co.
Canon City, Colorado
W. C. Porter, Vice President in Charge of Operations
Chester Huskey, Superintendent

Stearns-Roger Manufacturing Co., Denver Engineers—Constructors
Loeb & Eames, New York, Consultants

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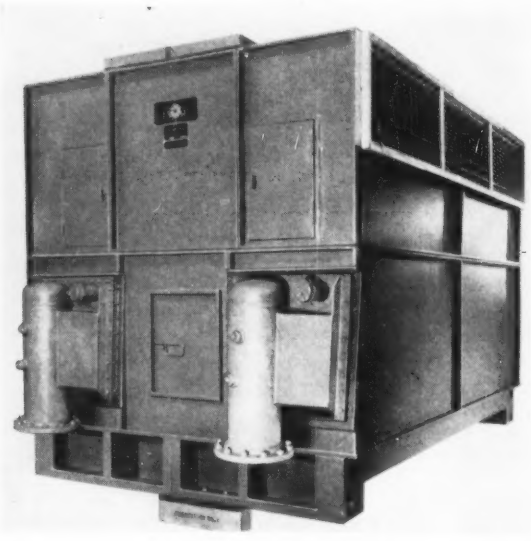
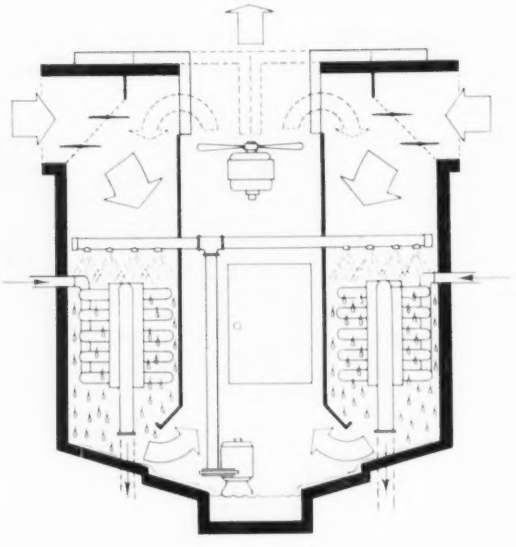
OTHER TYPES AND SIZES OF DETROIT STOKERS FOR EVERY INDUSTRIAL OR POWER NEED



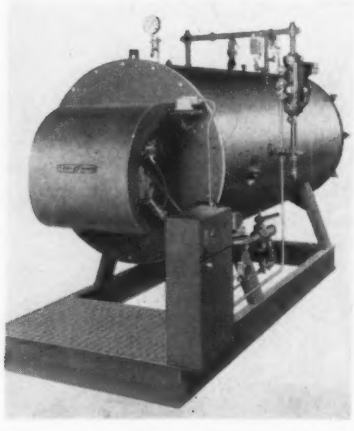


Vapor condenser cools by evaporation

109 • Unit uses principle of evaporative cooling with rejection outdoors of condensate heat. Vapors are condensed in two parallel-mounted water-sprayed coils enclosing central plenum under fan section. Air stream enters above coils, travels downward over them and enters plenum, where it drops its entrained moisture and passes up and out through fan. Spray water is recirculated; only a small amount is consumed (1000 Btu per lb of water evaporated, plus a small wastage, according to manufacturer).

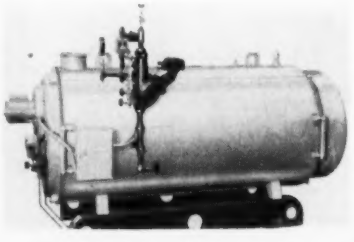
Condensate drains into manifold where screening baffle tube separates out noncondensibles. Noncondensible gases are subcooled seven to eight degrees and ejected. Vapor mixed with noncondensibles is returned through reflex tubes. Condensing temperature may be within 20 degrees of ambient wet-bulb. Installed on top of stripping column or above vacuum kettle, unit is said to form a self-contained compact system that is encased with removable panels for maintenance accessibility. —*Niagara Blower Co, 405 Lexington Ave, New York 17, N. Y.*

Packaged boilers are gas fired



110 • Automatic boiler line features burner head designed for efficient firing of natural or mixed gas. Air for combustion is supplied by blower at front of unit. Blower also forces hot gases through boiler passes. New design is said to (1) reduce needed air pressure (2) require smaller blower motor (3) consume less electricity.

Package includes boiler, burner and accessories. It comes in 12 sizes from 30 to 125 hp, supplies h-p steam, l-p steam or hot water. Guaranteed overall thermal efficiency is 80%.—*York-Shipley Inc, 500 Jessop St, York, Pa.*



Packaged boiler

111 • Automatic-operation packaged unit is designed for light and medium sized processing plants. Unit is said to eliminate need for expensive chimney; vent removes combustion gases from boiler room. Available through 60 hp or 2070 lb steam per hr, can be oil- or gas-fired or furnished with combination burner.—*Cleaver-Brooks Co, Dept M, 326 E Keefe Ave, Milwaukee 12, Wis.*

For more data on these items, use the post cards on page 163. Identify your request with item number

Keep yourself up to date . . .

To get more info on new equipment or FREE copies of latest bulletins

follow these easy steps

Preceding pages tell you what's new in plant equipment. Each item is numbered. For more details on any item, write its number here →

New free bulletins are listed and numbered, beginning on back of this page. To order those you want, write POWER item number here — *do not use manufacturer's bulletin number.* →

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LUBRICATION

1 **Lubrication systems** for small machines are subject of 24-p illustrated bulletin 4C. Describes cyclic and "one-shot" lubricators, discusses distribution systems, installation. Specs included. Bijur Lubrication Corp, 151 W Passaic St, Rochelle Park, N. J.

2 **Silicone lubricants** are discussed and illustrated in 8-p brochure 6-101. Tables and graphs are included, properties and performance described. Dow Corning Corp, Midland, Mich.

3 **Valve lubricants** are featured in 12-p illustrated bulletin. Contains characteristic listings, selection charts, servicing instructions. Meter and Valve Div, Rockwell Mfg Co, 400 N Lexington Ave, Pittsburgh 8, Pa.

4 **Molybdenum disulfide lubes** are topic of 16-p illustrated brochure 110. Technical aspects of extreme pressure lube are discussed. Has selection tables, application photos. Alpha Molykote Corp, 65 Harvard Ave, Stamford, Conn.

5 **Circulating oil system** is described in bulletin 70. System has automatic alarm, variable-delivery pump. The Farval Corp, 3249 E 80 St, Cleveland 4, Ohio.

WELDING

6 **Root-pass weld** is discussed in 12-p illustrated booklet. Describes tack welding, gas protection of inner surface. Includes dimension data, pipe specs. Arcos Corp, 1502 S 50 St, Philadelphia 43, Pa.

7 **Weldors' guide** EW-201 is 60-p illustrated booklet of arc-welding information. Gives details on metals and electrodes, definitions of terms, explanation of AWS classification numbers. Hobart Bros Co, Troy, Ohio.

8 **Welding of 4130 steel** is discussed in 8-p illustrated booklet ADR 112. Testing of electrodes, effects of equipment, preparation of weld are treated. Air Reduction Sales Co, 150 E 42 St, New York 17, N. Y.

9 **Welding profit** is subject of 8-p booklet D761. Discusses dual controls, parallel power, use of two steady arcs. Illustrated with action photos. Caterpillar Tractor Co, Peoria, Ill.

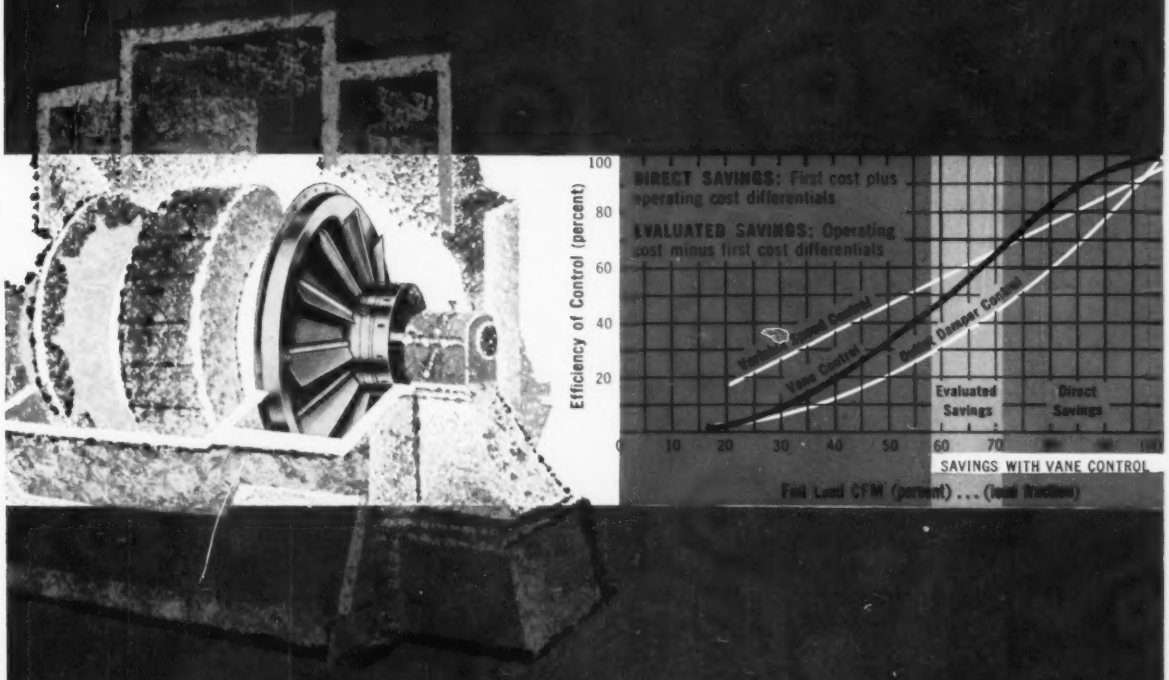
10 **Magnetic clamps** for setting up welding work, other welding aids are described in 4-p folder. Describes units, illustrates use. Aronson Machine Co, Arcade, N. Y.

WATER TREATMENT

11 **Cooling water** treatment case histories are subject of technical paper 137. Discusses problems of corrosion (*continued on page* 206)

DON'T SPEND $12,000 ON A $4,000 JOB

and still lose money on operating costs!



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Specify this simple, reliable and mechanically foolproof regulator of fan output for your combustion control. Action is smooth. Response to exact pressure and volume requirements is instantaneous, adjustment precise.

Westinghouse Vane Control can be used on Forced and Induced Draft! Available in distinct designs for clean air forced-draft and coal-fired induced-draft applications.

Hundreds of power plants are benefiting from the economy and effectiveness of Westinghouse Inlet Vane Control on Forced and Induced Draft Fans.

Call your local Sturtevant Division Sales Engineer today, or write Westinghouse Electric Corporation, Dept. A-15, Hyde Park, Boston 36, Massachusetts.

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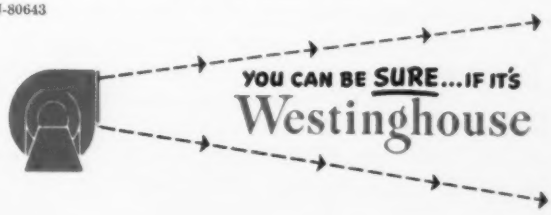


George Edwards

gets a look at a pocket-sized yardstick

Every now and then I either meet up with a fellow I'll call Tom Smith, or with someone who mentions him. I'd like to use his right name, but Tom's a little on the bashful side. He asked me not to in telling you this story.

He is a service engineer for a major equipment company and I wouldn't be surprised if a lot of his friends in the power field spot him in spite of my using a phony name for him.

Tom is a crackerjack at his job, and this alone would make him respected wherever he went. But he has other characteristics that make him stand out. I haven't met anyone—even among his competitors—who doesn't have a good word for him.

I nailed him down one day and asked him point-blank about himself. Told him that whatever his "charm school" was, it had sure done a good job. Tom grinned sheepishly and pulled a creased and well-thumbed piece of paper out of his wallet. "This," he said, "is something I got from the home office a good many years ago. It's supposed to be an on-the-job instruction sheet, but if a guy follows it in his dealings with *everybody*, he'll never have trouble getting along. I read it every so often. Sorta helps me keep on an even keel."

After reading it, I agreed 100% with Tom and I think you will too. It's headed, "A memo concerning relations with customers and consulting engineers," and reads as follows:

"There's an old saying that after one builds a house, he can see what he did wrong. This is especially true in our business and in some work done by consultants. There's seldom a job completed without someone being able to point out errors made either by us or the consultant. When such errors come to light, it behooves us to keep our traps completely shut. No one can blame us for what we think, but only for what we say.

"Some individuals delight in relating how they overcame mistakes on some prior job. Telling a customer this self-glory tale not only establishes you as a blow-hard, but makes the customer wonder about what you might be doing wrong and *not* be able to overcome on *his* job. Further, it's poor advertising to admit that we make mistakes that have to be corrected. Such mistakes speak for themselves in any installation.

"There is, naturally, much competition between various consulting engineers and general contractors. If we're smart, we'll stay on good terms with all of them. And a quick way to get on bad terms is to draw any comparison as to their ability.

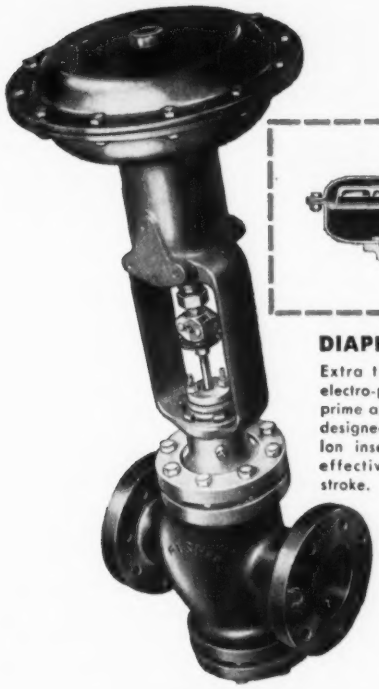
"Friendship is a mighty valuable asset in any business or personal relations. Getting it isn't complicated, either. It's just a matter of not losing sight of the golden rule. This may sound like a lot of malarkey to some people. But don't ever underestimate it.

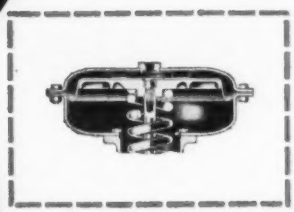
"In general, we can keep out of trouble simply by tending strictly to the business at hand and by remembering that idle gossip or criticizing other peoples' efforts usually boomerangs."

Any Way You Look At It

FISHER® Control Valves

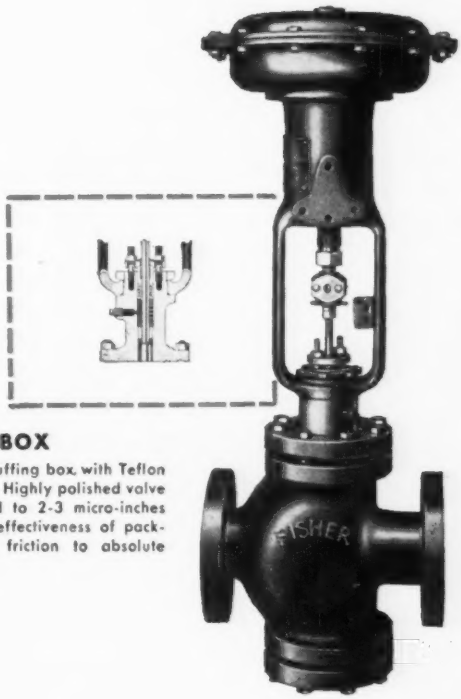
are your BEST BET!





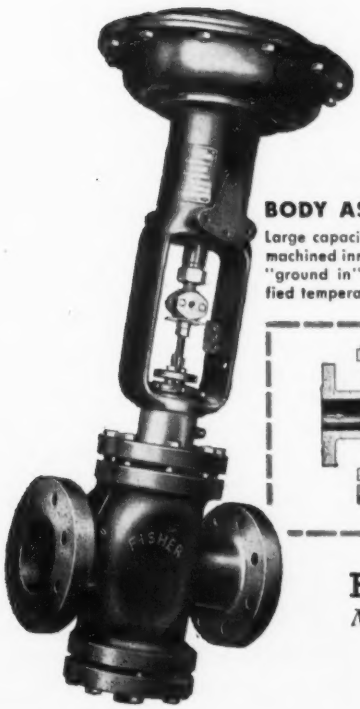
DIAPHRAGM ASSEMBLIES

Extra thick steel castings are zinc electro-plated, iridited and then given prime and final paint coats. Specially designed molded diaphragm with nylon insert gives practically constant effective area throughout valve stroke.



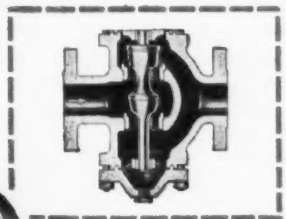
STUFFING BOX

Bolted gland stuffing box with Teflon V-Ring packing. Highly polished valve stem is finished to 2-3 micro-inches RMS to insure effectiveness of packing and keep friction to absolute minimum.



BODY ASSEMBLIES

Large capacity bodies with accurately machined inner valves are individually "ground in" under customer's specified temperature conditions.



Realizing their importance in the control system, Fisher has given careful attention to design and construction of diaphragm control valves. Any way you look at it — from the standpoint of durable construction or accuracy of performance—Fisher Diaphragm Control Valves are your best bet.

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RAMBLINGS ON INSTRUMENTATION

The Hays Menu of Combustion Guides

Wherever fuel is burned in any quantities, it makes good economic sense to invest in an instrument to continuously indicate and/or record combustion efficiency—that is, a combustion guide. Hays offers the most complete line of such instruments including:

1. The Magno-Therm Oxygen Analyzer
2. The Boiler Efficiency Meter or Air-Flow/Steam-Flow Meter
3. The Combustion Meter or Automatic Orsat
4. The Condu-Therm CO_2 Analyzer, an all electronic thermal conductivity measuring instrument

This month we'd like to describe the merits of:

Item 1—Oxygen on the Half Cell or La Pièce de Paramagnetic

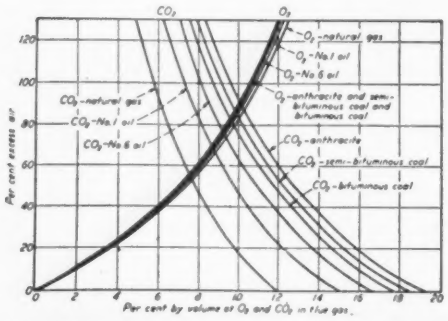
This fine product has been affectionately nicknamed the Hays Magno-Therm Oxygen Analyzer. It is, to put it flatly, the most widely accepted industrial type oxygen analyzer currently in production in the U.S.

Its operation is based on the exceptional paramagnetic property of oxygen, a quality not found in other commonly used industrial gases. No sample preparation is required other than nominal filtering and cooling. Its analyzing cell is inert, needs no electrode replacements and requires no fuel supply.

Ranges vary from a minimum of 0-5% to a maximum of 0-100%, with suppressed zero ranges of a minimum 5% anywhere in the spectrum. For example: 17 to 22% for analyzing the oxygen in smoke-filled rooms.

Some of the advantages of the Hays analyzer include high degree of sensitivity, rapid response, and almost monotonous accuracy.

O_2 analysis is particularly handy when switching from one fuel to another or burning more than one fuel at the same time. Why? Because oxygen and oxygen alone gives you an undistorted picture of the amount of excess air present in combustion gases. This fact is borne out by the graph below showing the relationship of excess air to CO_2 and O_2 in the flue gas of five common fuels. While the O_2 curves nearly coincide (especially in the important 30% excess air range) the CO_2 curves diverge widely. With any other type of combustion guide, you would have to re-calibrate for each fuel (when switching from one to another) or put up with extremely unreliable information (when burning multiple fuels).



Note uniformity of O_2 compared to CO_2, burning fuels of varying hydrogen/carbon ratios. (Write for detailed chart, 8½x11" in one glorious color, suitable for framing.)

We have a rather fascinating tome entitled "Combustion and Combustion Guides" which goes into this sort of thing in elaborate detail. If you'd like a copy, address your request to my personal attention and I will send you one promptly.

Phil Sprague Jr.

President

THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

Marmaduke

Continued from page 146

either. He charged his system with ammonia, but the head pressure wouldn't stay up and the box temperatures kept climbing.

"And let me tell you it was hot as a blowtorch on the Far East run that trip. Snifty was getting worried, so he came to me for help before the chief could find out about it.

"'Marmy,' he said, 'I'm having trouble with the temperatures. I can't find where all my ammonia's going and besides I'm a wee bit under the weather. If you can help me out before the chief comes poking his nose down below I'll blow you to all the drinks in Singapore!'

"Now Snifty was the biggest chiseler aboard, but we all liked him. He was always ashore drinkin' with us but he never paid the chits. It was worth doing this job to see him cough up for the drinks, especially in a sailors' port like Singapore.

"'It's a deal,' I said, getting out of my bunk. 'You turn in and keep out of my way.'

"I didn't waste time down below. If you can't smell leaking ammonia aboard ship, it's going only one place—overboard. I shut off the refrigerator condenser's cooling water and stuck my head out a porthole just aft and above the condenser's discharge. The ammonia fumes almost knocked me silly.

"I got the second assistant on watch to help me. The two of us had the ammonia pumped back into the box coils, the condenser apart, a new tube replaced and the system back in service by four bells on my morning watch. It was a hot and tough job, but a night ashore in Singapore at that deadbeat's expense was worth it.

"Snifty was happy about the whole thing when he got out of his sack. But when the second and I told him he was taking us to the Raffles Hotel bar instead of some waterfront dive, he shut up like a clam—and went below.

"'If that foxy tightwad doesn't beat us out of those drinks,' said the second, 'I'll eat your boiler suit stewed in lube oil. He's cooking up some way of getting out of paying for those drinks right now.'

"About two days out of Singapore,

(Continued on page 170)

CELLULUBES ASSURE...

THE SAFETY OF FIRE RESISTANCE

No Flashback
*Auto ignition point, °F.... over 1150
Hot manifold, mod., °F., Min.... 1350-1370
Molten metal, 1500°F.... no ignition

THE SAFETY OF EXCELLENT LUBRICITY

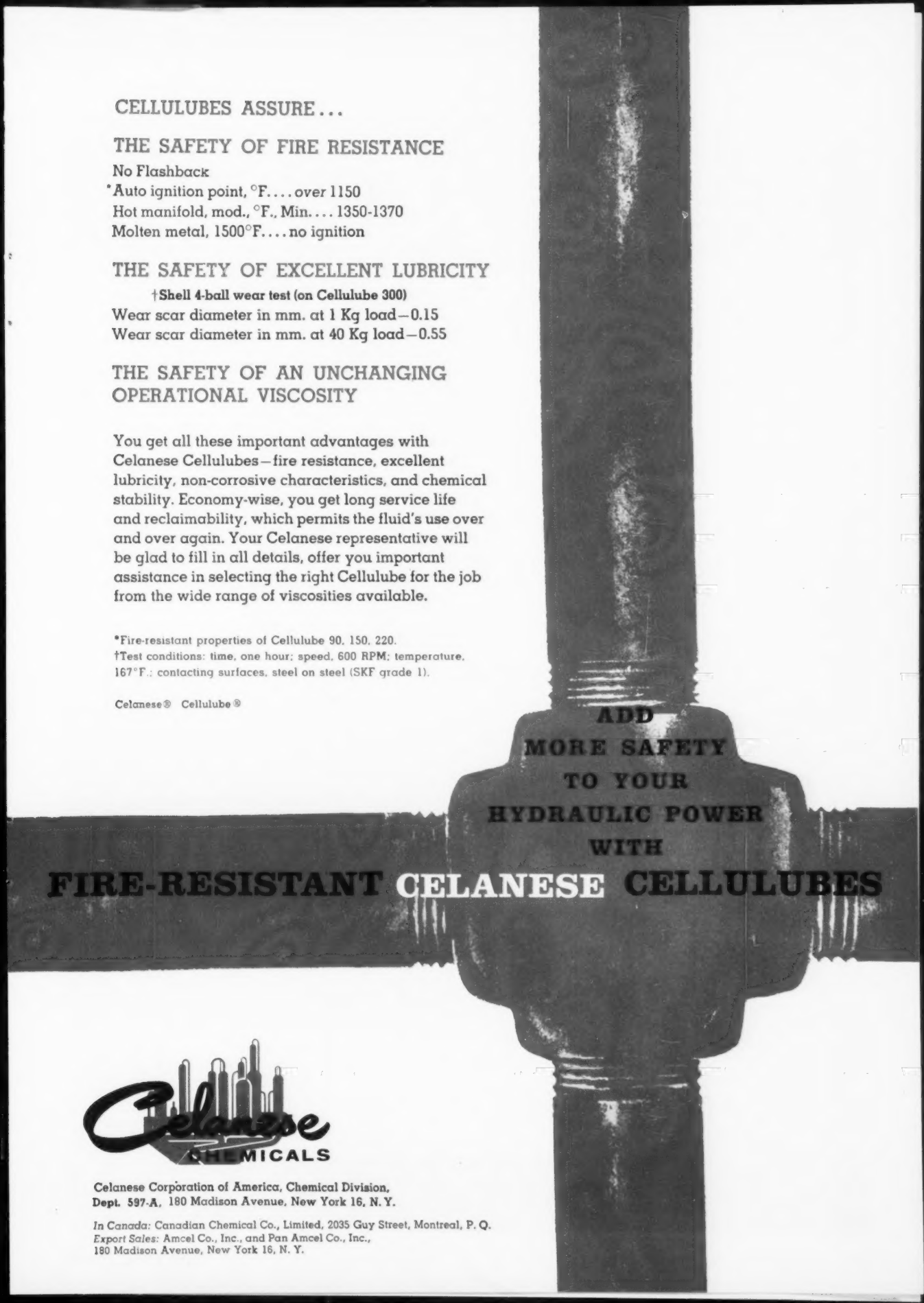
†Shell 4-ball wear test (on Cellulube 300)
Wear scar diameter in mm. at 1 Kg load—0.15
Wear scar diameter in mm. at 40 Kg load—0.55

THE SAFETY OF AN UNCHANGING OPERATIONAL VISCOSITY

You get all these important advantages with Celanese Cellulubes—fire resistance, excellent lubricity, non-corrosive characteristics, and chemical stability. Economy-wise, you get long service life and reclaimability, which permits the fluid's use over and over again. Your Celanese representative will be glad to fill in all details, offer you important assistance in selecting the right Cellulube for the job from the wide range of viscosities available.

*Fire-resistant properties of Cellulube 90, 150, 220.
†Test conditions: time, one hour; speed, 600 RPM; temperature, 167°F.; contacting surfaces, steel on steel (SKF grade 1).

Celanese® Cellulube®



Celanese CHEMICALS

Celanese Corporation of America, Chemical Division,
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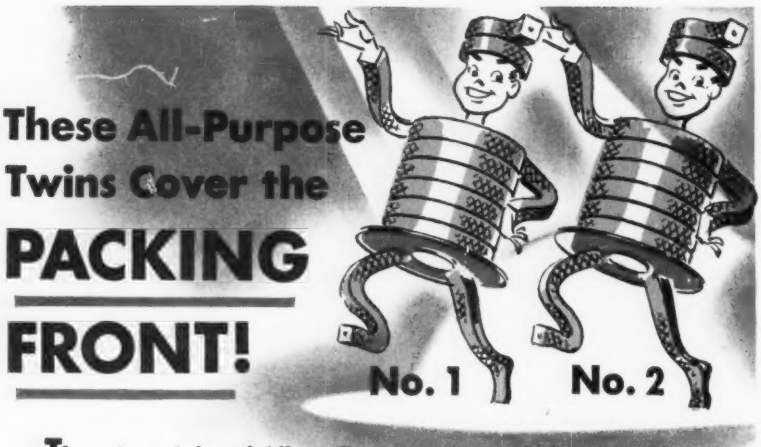
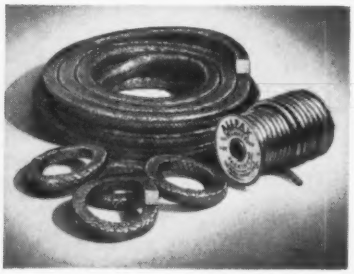


These two styles of Allpax Packing cover a wide range of applications and many different uses, consistent with the policy of our company—fewer packings for more services.

Both are compounded of the highest quality materials, and between them they cover against such service conditions as steam, water, air, ammonia, gases, oils, distillates, dowtherm, etc. They are for use on centrifugal and rotary pumps, valve stems, expansion joints and similar equipment.



Packaged in durable metal containers to insure protection and preservation of material. Applications and uses conveniently noted on each container.

Style No. 1 is really universal in its uses—where the temperature does not exceed 600 degrees F.

Style No. 2 also has an extremely wide variety of uses in higher temperatures, ranging from 600 degrees F. to 1200 degrees F. This is because of a special bonding compound, containing a heat-proof lubricant, which maintains the lubricant under high temperature conditions.

Both types are made in ring, spool or coil form in a wide variety of sizes. Allpax Packings do a better job for manufacturers and replacement use because they are precision-made, accurate in dimensions. They provide a tight seal without danger of scoring or unnecessary wear.

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160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 8, Quebec

Marmaduke

Continued from page 168

Snifty didn't show up for breakfast. The second and I went to the evaporator room, his favorite hangout. There was Snifty laid out on deck. He had a big bruise on his temple. Seems he slipped when the ship took a heavy roll and bounced his head against the brine tank.

"I snatched his bottle of Sandpaper Gin from the coils, pulled out the cork and held it under his big red nose. But he didn't bat an eyelash. That's when we knew he was done in for good.

" 'Didn't I tell you he'd beat us out of those drinks,' whined the second. 'It's just like him to kick the bucket and get the last laugh on us.'

"When we told the skipper, he said we'd better leave Snifty where he was —the evaporator room would keep him as well preserved as any shoreside morgue. So we lashed him to the coils and left him there.

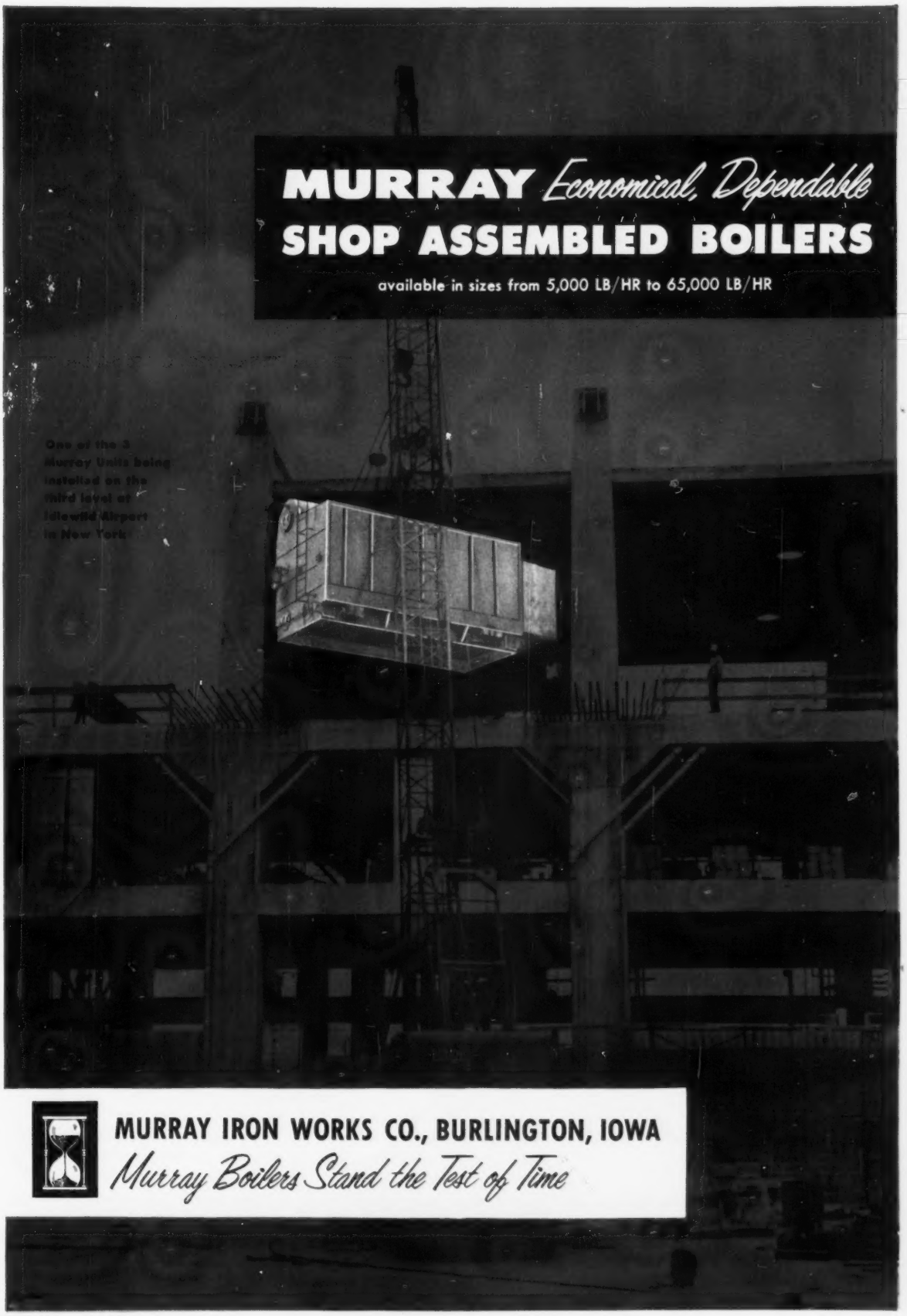
"Snifty looked sad sitting up with his eyes closed, until the first stuck a half-filled bottle beside him. Getting into Singapore a couple of days later, I went to check on Snifty. There he was with his eyes wide open and a smile frozen on his face.

"On the night after we pulled into Singapore, the Second and I went ashore for a few drinks. The more I thought about Snifty pulling a fast one and beating us out of those drinks, the sorer I got. About midnight I had a bright idea. Why not go back to the old rust-bucket and bring Snifty ashore? When I told the second, his eyes lit up and he said, 'That's a swell idea.'

"We dressed Snifty in his shore-going clothes—after we thawed him out a bit. He always wore a 'high-pressure' cap ashore, so we put that on and pulled it down over his eyes. Then we put our arms under Snifty's and walked him down the gangplank, with his feet dragging like someone dead drunk.

" 'Let's do this heathen hole up right,' I said. 'Let's go to the Raffles because the drinks are on Snifty after all.'

"Our ship had docked at the old West Wharf. From there, we walked Snifty a few hundred feet to Nelson Road and got into a gharry. Snifty sat between us. 'Raffles Hotel,' I yelled to the driver, rattling a fistful

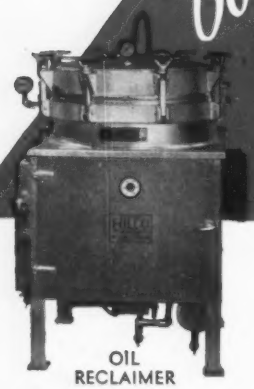

MURRAY Economical, Dependable
SHOP ASSEMBLED BOILERS
available in sizes from 5,000 LB/HR to 65,000 LB/HR
One of the 3 Murray Units being installed on the third level at Idlewild Airport in New York
MURRAY IRON WORKS CO., BURLINGTON, IOWA
Murray Boilers Stand the Test of Time

HILCO OIL RECLAIMERS

REMOVE WATER, SLUDGE, ACID

for complete

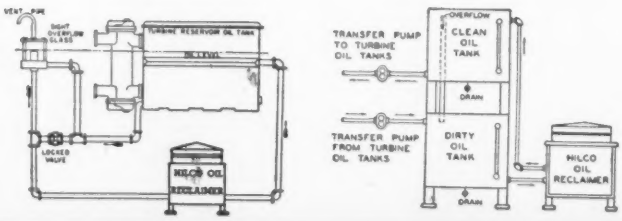
TURBINE OIL CONDITIONING...



OIL RECLAIMER

The HILCO Turbine Oil Reclaimer is a self-contained, compact unit that will produce and maintain oil free of all solids, sludge, acids, moisture and air, keeping the oil in first class condition. Its purifying process is a continuous, all electric, automatic operation, requiring infrequent attention. It removes contaminants as fast as they are formed, maintaining lubricating oil at full value of new oil. HILCO Oil Reclaimers will also purify compressor, hydraulic, insulating, Diesel and gas engine lube oils.

Purifies Turbine Oil by Continuous or Batch Purification . . .



A continuous, direct-connected, foolproof oil reclaiming system. Oil flows from turbine reservoir tank to sight overflow glass, to HILCO Oil Reclaimer, and back to reservoir.

A batch system designed to serve one or more turbines when it is desired to withdraw all the oil from reservoir for complete periodic batch reclaiming to restore all oil as good as new.

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Marmaduke

Continued from page 170

of silver under his nose. In those days, the Raffles was the fanciest hotel in the Far East. The silver did the trick. The driver made that hay-burner eat the dust along the Kampong Bharu Road, and before it settled we were stopping on the driveway in front of the Raffles.

"It was Saturday night, and the veranda was filled with rich rubber planters and their wives and guests. The place was full of life. You could hear the ice clinking in cool, tall drinks, the fizz from seltzer bottles, the tinny music of an Oriental band and the buzz of electric fans moving the hot air from one place to another. Yes, sir, that was quite a place.

"Well, before anyone knew the score, we marched Snifty up the veranda steps and sat him down at a table between us. We rested his head on his folded arms over the small round table.

"In a short time, the No. 1 Boy came for our order. He eyed Snifty suspiciously. 'Him no sick? Him no dlunk?' he asked, pointing to our shipmate. 'Naw,' I said. 'Him not sick. Him not drunk. Him plenty thirsty. You bring three Singapore Gin Slings. Chop, chop.' I knew the native lingo in those days.

"The No. 1 Boy was impressed and soon returned with the drinks. Those cold Gin Slings sure hit the spot. We emptied our glasses and then split Snifty's between us. In a few minutes, we ordered another round.

"Every time No. 1 Boy came he found three empty glasses. We sure had him guessing but he was too busy to stick around. About the fifth trip, he said, 'Him funny man. Him all-a-time sleep an him all-a-time dlink. Him funny man.' Then he left a fist-full of chits because it was closing time—3 am.

"Our ship was shoving off for Colombo at 4 am so we had to leave anyway.

"As soon as No. 1 Boy got out of sight, we shoved the chits in front of Snifty and made for the stairs. We hopped into a gharry and broke the record we set coming from the ship. The gangplank was just being pulled in as we jumped on it.

"We sure hated to leave the Raffles in such a hurry, because we

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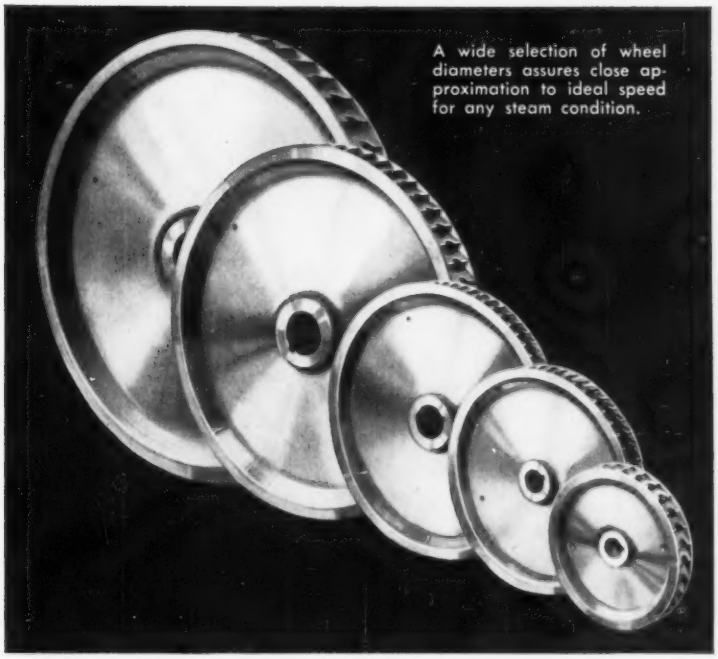
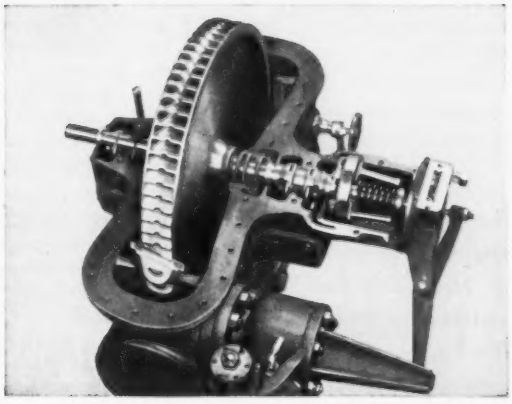


A wide selection of wheel diameters assures close approximation to ideal speed for any steam condition.



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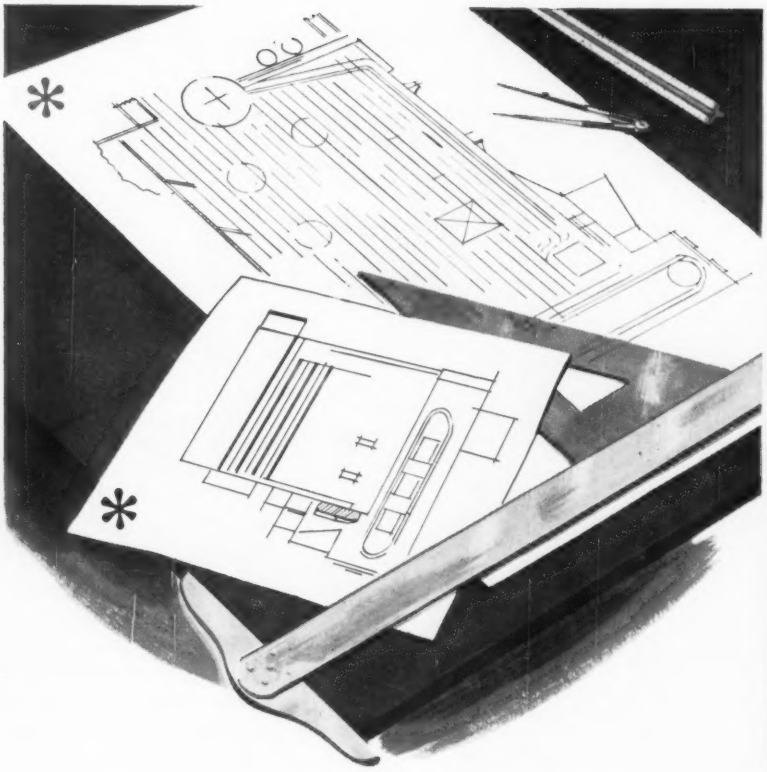

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Marmaduke

Continued from page 172

wanted to see No. 1 Boy's face when he tried to collect for all those high-priced drinks from poor old Snifty —may his soul rest in peace."

"Yes, sir," finished Marmy, watching the *Penang* plow past the battery, "Snifty didn't know it—but he finally blew us to those drinks, after all."—STEVE ELONKA

EDITOR'S NOTE: *This story is reprinted by request, first published in "Operating Engineer," Nov 1948.*

Marmy's Mailbox

'Tis here you exchange blasts with the old boy

THINKS OF MODEL-A

Marmy's story in May brought memories of the Model-A Ford. Gasoline tank was in front, gage was a float type. Gas-tank cap was same as radiator cap. A friend traveled a few miles in his new Ford when the engine stopped. He checked the gas, had plenty; stepped on the starter and off he went. Soon the car stopped again. Again he checked the gas by removing the cap—had enough gas, again the car started. This start-and-stop kept up until he got to the first filling station. The mechanic exchanged the gas-tank cap with the radiator cap, as it had a vent. The vacuum created inside the gasoline tank prevented the gas from flowing to the carburetor until the cap was removed. Ford soon made those two caps plenty different.

G G AVANT, *Wilmington, N. C.*

THINKS OF MARMY AT SEA

I'm on a two-week navy reserve training cruise, reliving some of Marmaduke's memorable and exciting escapades of the sea. I know Marmy could show us a thing or two about running a sea-going plant if he were here, but I'll have to absorb his teaching via POWER when I get back to shore.

J W DAVIS, *Los Angeles, Calif.*

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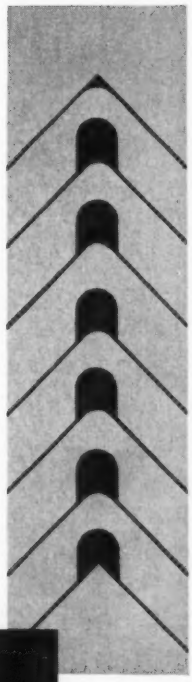
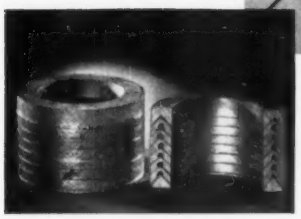
A NAAB, *Indianapolis, Ind.*





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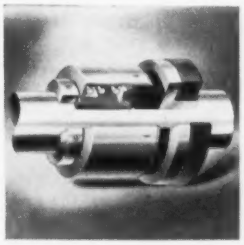

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Reactor boiler tubes

Continued from page 83

transfer surface is less expensive than prime surface. (2) Heat-transfer surface can be a less expensive material than containment tube material. (3) Perpendicular fins permit a higher concentration of surface per linear foot than longitudinal fins. (4) Crossflow transfer rates are higher at lower mass velocities than with longitudinal flow. (5) Large flow areas are available with long tubes and minimum number of tube-to-tube sheet attachments for less costly equipment.

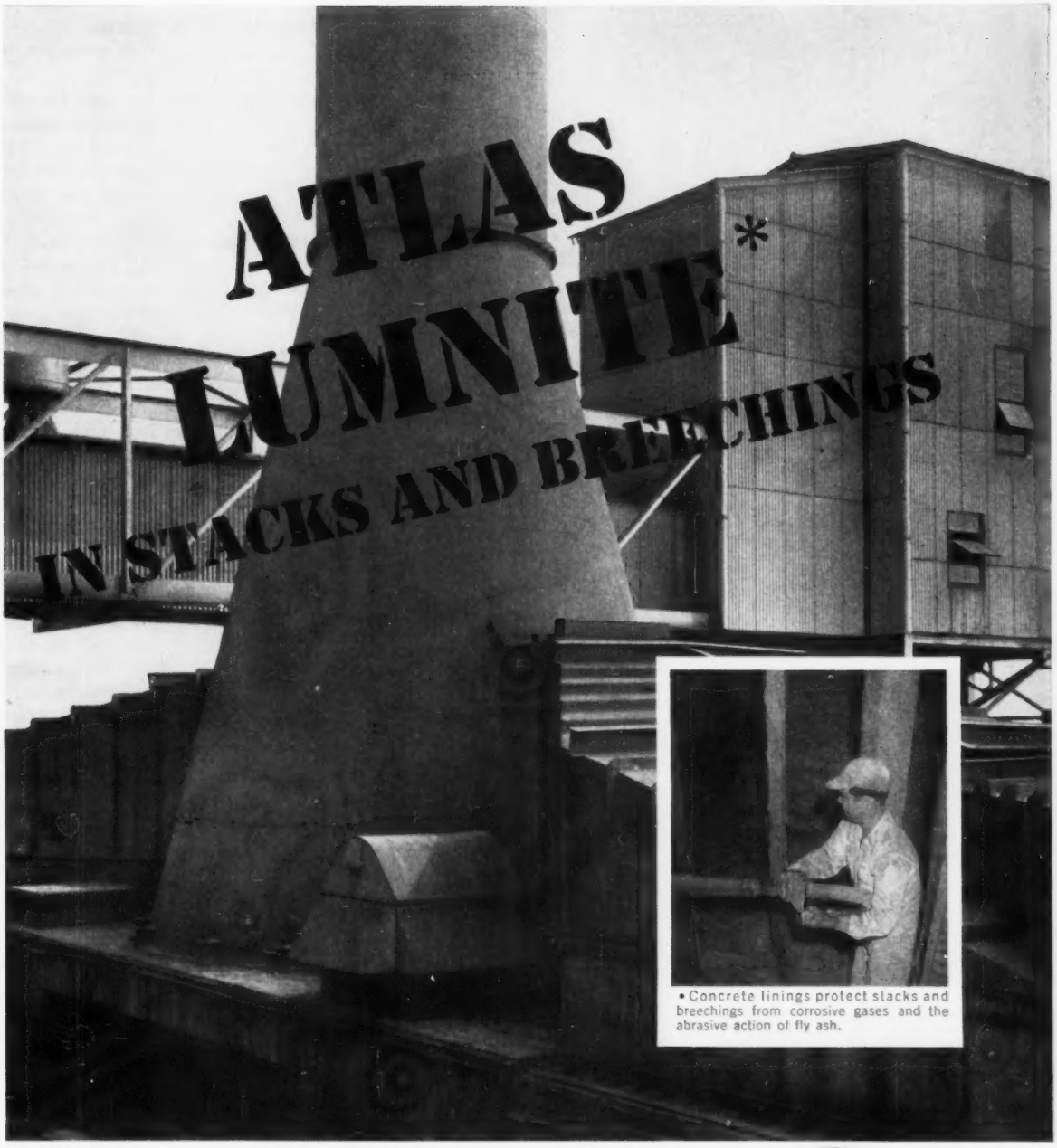
Disadvantages—(1) In heat-transfer area, crossflow is almost mandatory. (2) Baffling needs for small flows and long temperature ranges cause high percentage of parasitic pressure loss. (3) Additional surface is needed because of poorer surface efficiency.

Longitudinally finned tubes. One maker welds U-shaped channels to the tube exterior. This has advantages in wide selection of fin spacing, height and thickness on many different tube sizes. Disadvantage is limitation of choice of fin materials with tube materials.

Another maker offers a mechanically locked fin, as described above for the helical fin. This gives freedom of choice in materials for tube and fin. It has disadvantages in the difficulty of working a tough work-hardening material like stainless steel on the tubes and a limited choice of tube sizes and fin size, thickness and spacing.

Generally, the reliability of the fin-to-tube bond is about equal, with the welded fin having a slight edge. Under corrosive conditions each fin-to-tube bond has failed where the other has maintained its integrity. Welding fin to tube affects the tube metallurgy and has caused tube failures.

Longitudinally finned tubes usually do not have as much fin surface as the perpendicular-fin tube. The former is better with a cylindrical shell and when gas pressure is higher and more pressure loss permissible. Consider this design for smaller gas flows with long temperature ranges. Fig. 2 shows two modified types of these surfaces. We seldom use the interrupted fin for low Reynolds number in gas-cooling units. The curled-over fin permits tighter packing of surface in a shell and a self-support-



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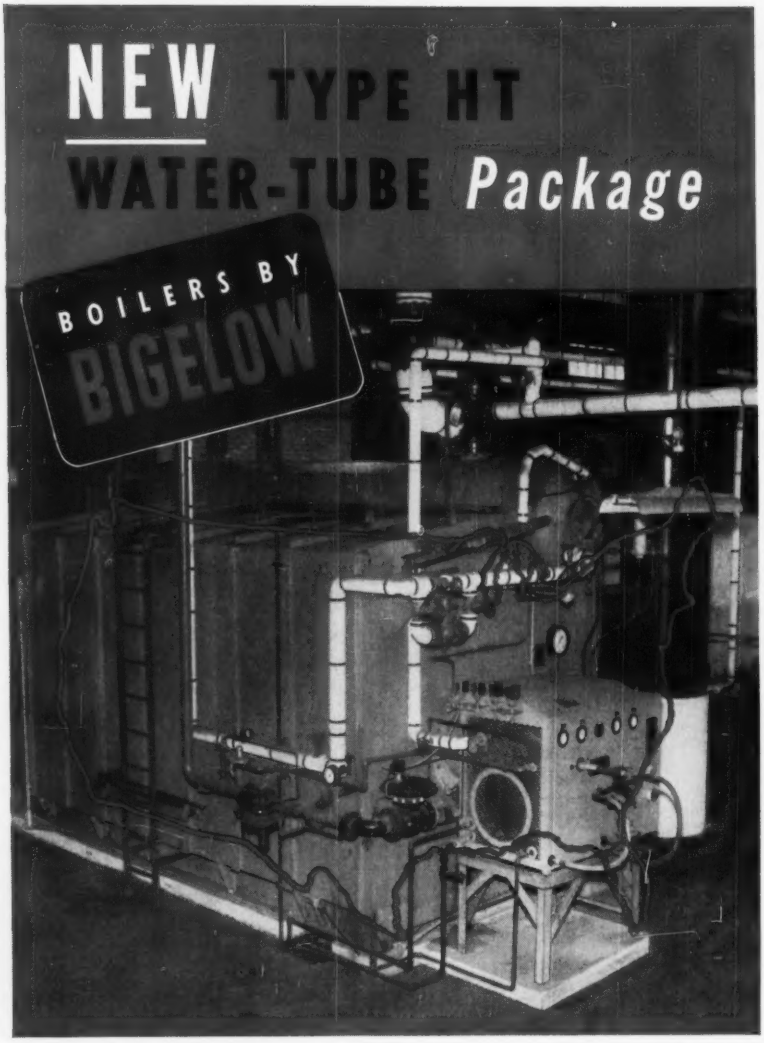

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B1-19

Reactor boiler tubes

Continued from page 176

ing design without the need for support plates across the entire bundle.

Advantages—(1) Generally, it has minimum parasitic pressure loss for long temperature ranges and small gas flows. (2) Equipment cost is reduced because of extended-surface compact design. (3) Permits use of less costly heat-transfer surface than needed for containment.

Disadvantages — (1) Longitudinal flow is mandatory. (2) Additional surface is needed because fin surface is less efficient than bare surface.

Stud fin tubes have pins, spines, cylinders or pyramids applied to a tube as a fin surface. Studs may be worked up out of thick-walled tubes or welded to the tube, Fig. 1. Studs of solid material are mostly used. A steel-jacketed copper-cored stud has been successfully developed.

The Calder Hall reactors in Britain use this type of tubing, Fig. 4. This surface may be used in either longitudinal or crossflow designs. In longitudinal flow both the transfer rate per foot of travel and the pressure loss is higher than for longitudinal fin tubing. There is, however, usually less surface per foot of length. Crossflow units reduce these advantages and the perpendicular fin tube is less expensive per Btu of heat transferred, all other conditions being equal.

Present fabrication methods make it impractical to use mixtures of fin and tube materials except for steel-jacketed solid-copper studs welded to steel tubes.

Stud fin tubes are more rugged perhaps than the finned units but have a coarser arrangement. This will multiply the outside surface of the tube about six times, but finer fins increase the surface by as much as 20 times.

Advantages—(1) May be used with crossflow, longitudinal flow or combination. (2) Usually is a rugged structure.

Disadvantages — (1) Coarse arrangement of studs needs larger units. (2) Fine arrangements are less rugged than perpendicular or longitudinal fins. (3) Surface is more expensive than other types. (4) Choice of material combinations is limited.

References. (1) *Efficiency of*

(*Continued on page* 180)

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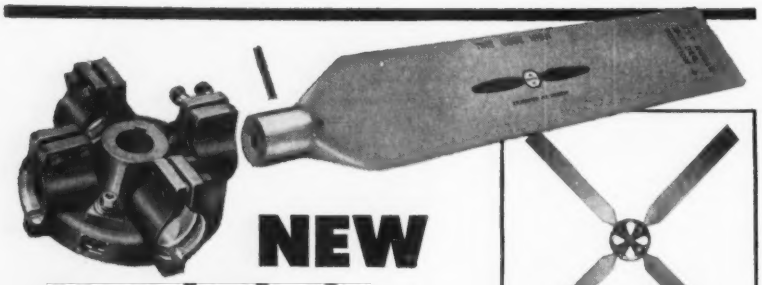

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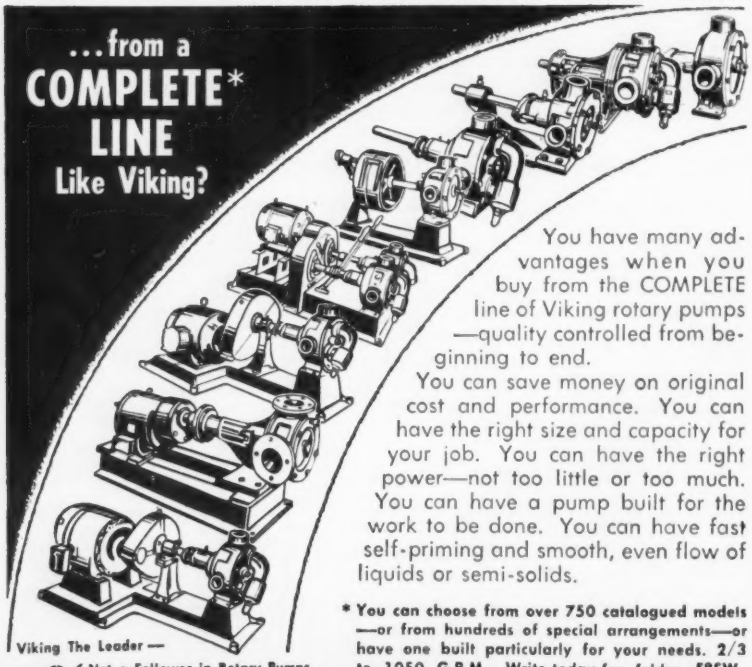

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Reactor boiler tubes

Continued from page 178

Extended Surface, by K A Gardner. Trans ASME, Vol 67, pp 621-631 (1945).

(2) *Combustion Heating Section*, by P E Carroll and R W Schroeder, *Liquid Metals Handbook—Sodium-NaK Supplement*, TID 5277.

(3) *Compact Heat Exchangers*, by W M Kays and A L London, National Press, Palo Alto, Calif.

(4) *A Study of the Steam Generator Requirements For the SAR Program*, by J P Silvers, Argonne National Laboratory Reactor Engineering Division, Technical Memorandum 6, ANL-JBA-20.

Part 2 will cover specific designs of steam generators—in a forthcoming issue.

Governing systems

Continued from page 119

ceding it dictates, there is no speed variation at all. We try to reach this ideal by using preloading springs, special pivots, etc.

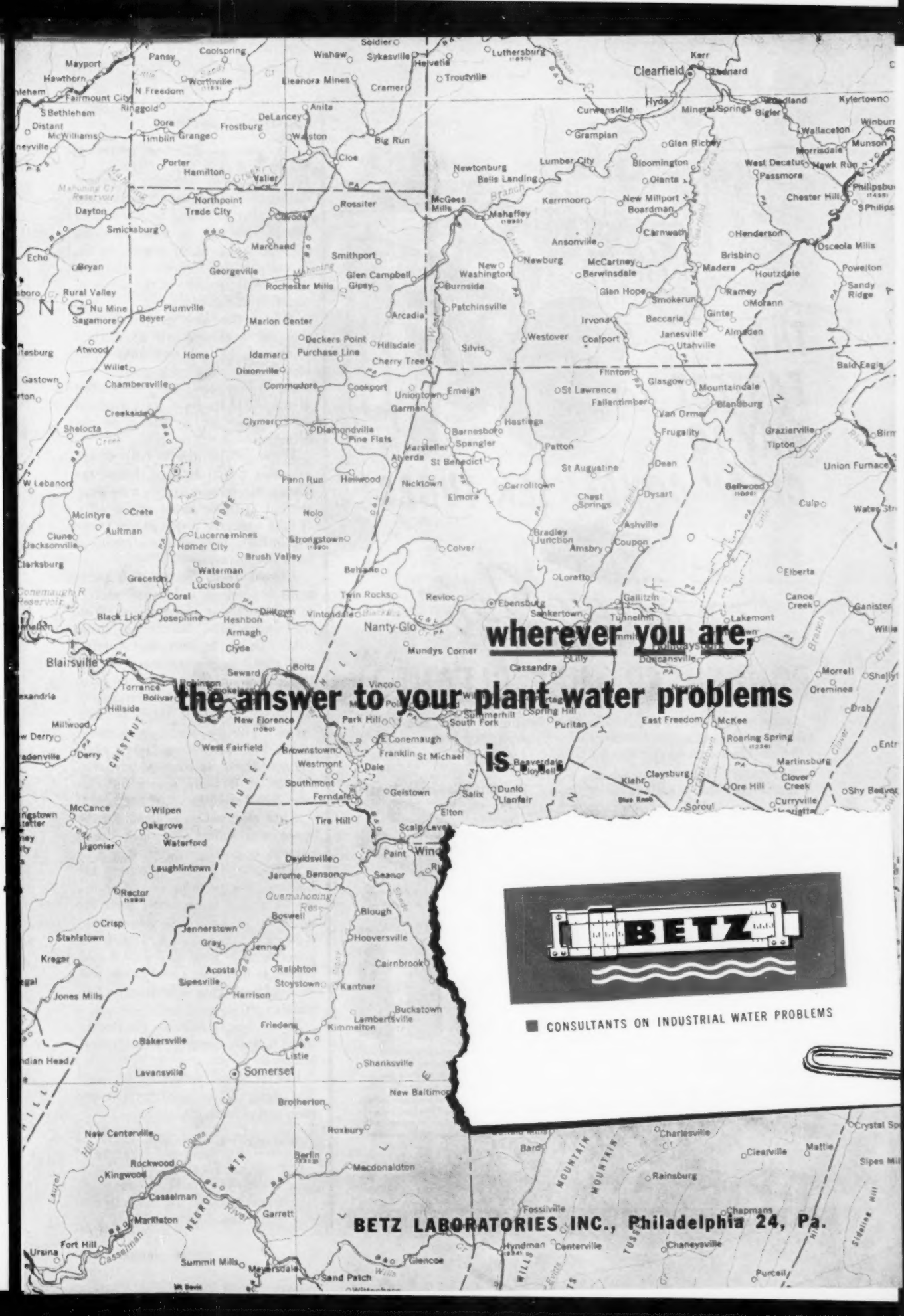
Now we have a governing system, Figure 4, that is stable but has a speed droop. Compensation can only be obtained by using a manual speed-changing wheel.

If we add a self-centering spring to the restoring lever, Figure 5, we will have forces working to push the pilot-valve bushing back to the position it held at 50% load in Figure 3. If we also disconnect the link between the piston and the restoring lever, this spring *will* push the bushing back to its original position.

If we insert the missing link, we will have good stability, wide regulation and poor speed offset. The results are similar to those in Figure 4. If the link is left out, we will have poor stability, narrow regulation and small speed offset—pretty much the same performance as Figure 2.

Self-centering spring so far has accomplished nothing. It merely adds a bias (extra force for something to overcome) to the restoring lever that tends to maintain one position of the bushing.

What is needed is a way to make the system act as if the link were out only when the transient (changing) effects slow down and equilibrium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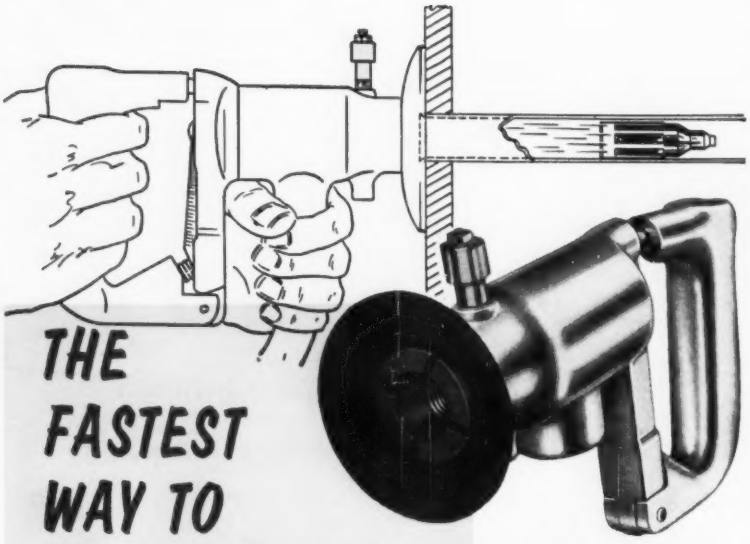

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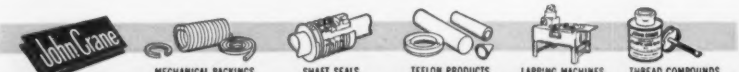


CRANE PACKING COMPANY

Governing systems

Continued from page 180

begins to set in. Stability is wanted during change with only a small speed droop after returning to the desired speed. This can be done by using a piston and cylinder containing oil. A variable orifice controls the flow of oil from one side of the piston to the other in Figure 6.

When the link is first moved, the piston-cylinder acts as a rigid joint and the restoring lever operates like the standard governing system. As time passes, the needle valve allows oil to flow around the piston as the reset spring pushes on the cylinder.

If the needle valve is fully closed, assuming no oil **leakage** around the piston, the reset action is zero since the link is rigid. If the needle valve is fully open, the piston moves freely within the cylinder and the restoring lever will not move.

Closed needle valve gives speed control which is stable and subject to wandering, or speed droop. With the needle valve fully open, speed control is so sensitive that hunting and possibly ever-widening oscillation will occur. With the needle valve set just right, the speed returns to set speed in about three to four cycles. With the needle valve closed just a little more than "just right," the speed returns more slowly. Examples of this are shown on Figures 7, 8, 9 and 10.

After reset action is complete, the speed still suffers the small droop present, as in Figure 2.

When the reset spring pushes the bushing back to its original position, the controller is no better than the governor in Figure 2. The advantage of fluid restoring is that the governor is as good as Figure 2 with respect to minimum speed droop, and as good as Figure 4 with respect to stability.

Here's how to calculate the steady-state turbine speed and control-oil pressure:

Plot of speed versus oil pressure is a straight line based on our assumption of linearity.

$$y = m\,x + b \text{ where } m = \frac{x_2 - x_1}{y_2 - y_1}$$

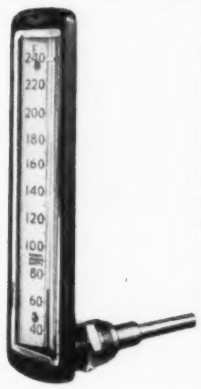
Example of Figure 2 illustrates a pilot valve which increased oil pressure from 20 to 80 psi for a speed

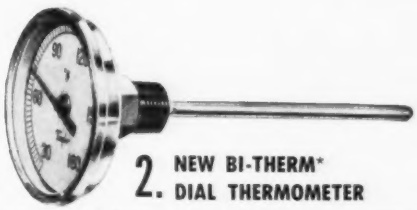
(*Continued on page* 184)

Taylor shows you 6 ways TO CUT COSTS

1. TAYLOR INDUSTRIAL THERMOMETER

Ideal wherever an accurate check is needed on recording or controlling instruments. Available in many standard ranges and mounting angles. BINOC* tubing makes it 3-times-easier-to-read.





2. NEW BI-THERM* DIAL THERMOMETER

An easy-to-read, inexpensive, reliable thermometer, ideal for pipe line and storage tank service. 3″ or 5″ dials, 4″, 6″, 9″, and 12″ stems. Separable wells. Accurate to ±1% of scale because unaffected by ambient temperatures. Range limits minus 40 to plus 750°F.

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For desuperheaters, or for any close, accurate control of temperature, pressure, flow or liquid level. Quickly adapted to operating requirements.

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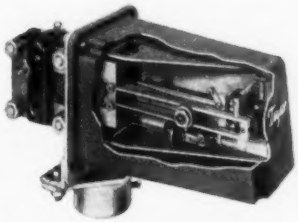
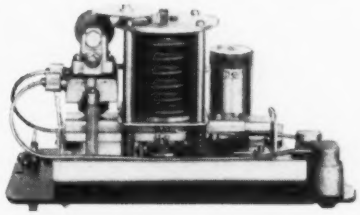
For temperature and pressure measurements. Has an all-new design movement for greater sensitivity on any type of measuring job. New case can be flush or face mounted, is fume and moisture proof. Big selection of standard ranges.



5. TRANSAIRE* DIFFERENTIAL PRESSURE TRANSMITTER

A rugged, dependable and accurate instrument designed to measure flow, liquid level or specific gravity. Taylor's latest addition to TRANSET* System of transmitters, receivers and controllers.



6. TRANSAIRE TEMPERATURE TRANSMITTER

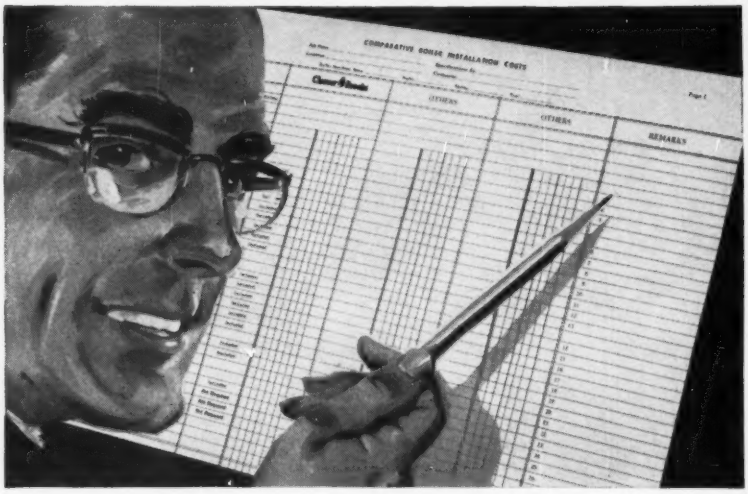
Compact and super-responsive. Designed to measure and transmit smallest temperature changes up to 1,000 feet with great accuracy. Provides dynamic accuracy, thanks to derivative action in the measuring circuit. Similar instruments for highly accurate pressure measurement.

These Taylor instruments have been successful for years in helping to reduce costs, and maintain efficiency of expensive equipment. They are accurate, and for all their sensitivity, are remarkably rugged. An experienced Taylor Field Engineer will be glad to talk over your particular cost control problems . . . and show you how Taylor instruments can help solve them. Write to Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ontario.

*Reg. U.S. Pat. Off.

***Taylor Instruments* MEAN ACCURACY FIRST**

Before you buy any boiler
compare quoted prices with REAL COSTS



New Cleaver-Brooks cost analyzer clears "quotation" confusion — reveals ALL costs

Get *all* the costs . . . the *real* costs . . . down on paper before you recommend or specify a boiler to your clients. On many boiler installations "quoted prices" seldom agree with the total costs, as you may have learned. This is frequently the case with so-called "built-up" boilers assembled on the site.

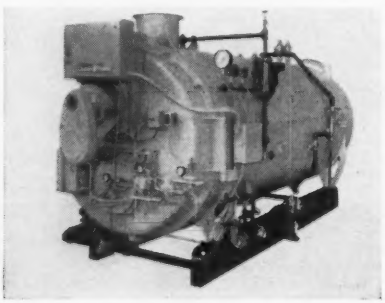
Cleaver-Brooks' cost analysis enables you to compare all material costs (boiler, steam trim, burner, refractory, controls and other equipment) and installation labor costs. You'll know the "real costs" on the complete installation before you start.

Real eye-opener

The figures you'll see may be startling. In most cases the cost analysis proves a Cleaver-Brooks costs *less*. On-job time is drastically reduced because Cleaver-Brooks packaged units are fully assembled, ready to install. Cleaver-Brooks boilers give you more in performance, too . . . each boiler is fully fire-tested at the factory under load, tuned to peak economy. Starting service and on-the-job operator training by authorized field engineers further decreases your over-all costs.

Contact your Cleaver-Brooks agent

Once you add up all the benefits of a Cleaver-Brooks "one-cost" package . . . the proved trouble-free economy of exclusive four-pass, forced-draft design, you'll find it pays over and over to analyze costs carefully before you buy. See your Cleaver-Brooks agent for details or write Cleaver-Brooks Company, 301 E. Keefe Ave., Milwaukee 12, Wisconsin, Dept. A.



Choose from 19 sizes, 130 models, 15 to 600 hp. Oil, gas and combination oil/gas fired — steam or hot water for heating or processing.

Cleaver Brooks
ORIGINATORS OF SELF-CONTAINED BOILERS

Governing systems

Continued from page 182

change from 3000 to 2970 rpm.

Let N = speed and P = pressure

$$N = \frac{2970 - 3000}{80 - 20} P + C$$

$$N = -\tfrac{1}{2} P + C$$

At 3000 rpm, P = 20

$$C = N + \tfrac{1}{2}P = 3000 + \tfrac{1}{2}(20) = 3010$$

$$N = -\tfrac{1}{2}P + 3010$$

This equation shows the effect that pilot valve movement (caused by the change in flyball position) has on control-oil pressure.

Movement of the steam valve, caused by oil-pressure change from 20 to 80 psi, causes a turbine-speed change from 1500 rpm to 4500 rpm at the new load. Solved as a straight line, this equation is:

$$N = 50 P + 5000$$

The balance of flyball position, pilot valve movement, oil pressure and turbine speed is found by solving these two equations simultaneously.

Following values will satisfy both equations—governor and governed:

$N = 2985.15$ @ $P - 49.703$.

In Figure 4, the pilot valve increased oil pressure from 20 to 80 psi with a movement from 3000 rpm to 2940 rpm. This is solved with these two equations:

$$N = -P + 3020$$

$$N = 50 P + 5000$$

$N = 2970.5883$ at $P = 49.4117$

Compressed air

Continued from page 95

pressurized air draws on its internal energy to produce the work, we find its temperature drops below T_a, even though Q_{ae} enters the air during expansion. (In the constant-T cycle, Q_{ae} prevents the drop in temperature.) As the exhaust air returns through the atmosphere from engine to compressor it absorbs heat Q_{aa}, hatched area.

PV graph shows that work flow into the system W_{in} is larger than work output W_{out}. The net cycle area for the system *1-2-3-4* measures the work lost by the system — external temperature irreversibilities cause this. We have, however, considered all the processes as internally reversible.

This contrasts with the engine

(*Continued on page* 187)

DETROIT EDISON COMPANY
Insulates to get More Useful Heat . . . with
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To save every possible Btu for power generation, Detroit Edison selected thermally efficient B-H Mono-Block for insulating furnaces and waterwalls.

Because B-H Mono-Block is felted of high temperature-resisting spun mineral wool fibers, it provides extremely low thermal conductivity in one block over the full range of temperatures to 1700° F. This block also facilitates and speeds application due to its light weight and ease of cutting to any shape required.

At Detroit Edison's Conners Creek and St. Clair power plants, B-H Mono-Block, in size 18" x 24", 3" thick, was secured tightly against the refractory cement boiler covering by tie wires fastened to horizontal pencil rods. Joints between the blocks were pointed with B-H No. 1 Insulating Cement to form an unbroken layer of effective insulation.

See the B-H catalog in Sweet's Plant Engineering File

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Write for new 1958 brochure on B-H Mono-Block and its companion product, B-H Improved Super Powerhouse Cement.

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- **Allows simplified, straightaway piping** — for faster, easier, less costly installation. No elbows needed.
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- **Sizes**—2½ to 6 inches.
- **Pressures**—Up to 250 psi at 406 F and 400 psi at 70 F.

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Continued from page 184

cycles we have studied; for these, net areas measured shaft work output; but for compressed-air systems, net area measures work lost. Remember, completely available energy, shaft work, runs our compressed-air systems; high-temperature heat runs our engine cycles.

To continue our analysis, from the circuit flow diagram we know:

$$W_{in} + Q_{ae} + Q_{aa} = W_{out} + Q_{re} + Q_{ri}$$

$$W_{in} - W_{out} = Q_{re} + Q_{ri} - Q_{ae} - Q_{aa}$$

From the PV graph we learn:

$$W_{lost} = W_{in} - W_{out}$$

Substituting from the energy flow balance:

$$W_{lost} = Q_{re} + Q_{ri} - Q_{ae} - Q_{aa}$$

The last equation means that the net area *1-2-3-4* on the TS graph also measures the net work lost, even though this is in Btu rather than ft-lb as on the PV graph.

Constant-S system, Fig. 4*f* and *g*, uses adiabatic compression and expansion (zero heat transfer). All heat added to the cycle comes from heating the engine exhaust by Q_{aa}. Heat rejected from the cycle Q_{ri} leaves through the aftercooler.

Adiabatic expansion of the air in the engine causes a maximum temperature drop of the exhaust. Adiabatic compression causes a maximum temperature rise of the compressed air. These effects combine to cause the greatest work loss of any compressed-air system, when pressurized air must be cooled back to atmospheric temperature. The energy analysis parallels the one we just made for the polytropic system. This shows that net areas on both PV and TS graphs measure the work lost.

If the pressure parts of an adiabatic system can be thoroughly insulated to prevent loss of Q_{ri} and the aftercooler dispensed with, this would be an efficient energy transmitting system, with no work lost. The compressor would work along *1-2* in Fig. 4*f* and *g* and the engine along *2-1*. There would be no areas on the TS graph, and the two areas for compressor and engine would be equal on the PV graph.

Compressed-air systems as refrigerators and measuring compressor performance will be covered in next part—in an upcoming issue.

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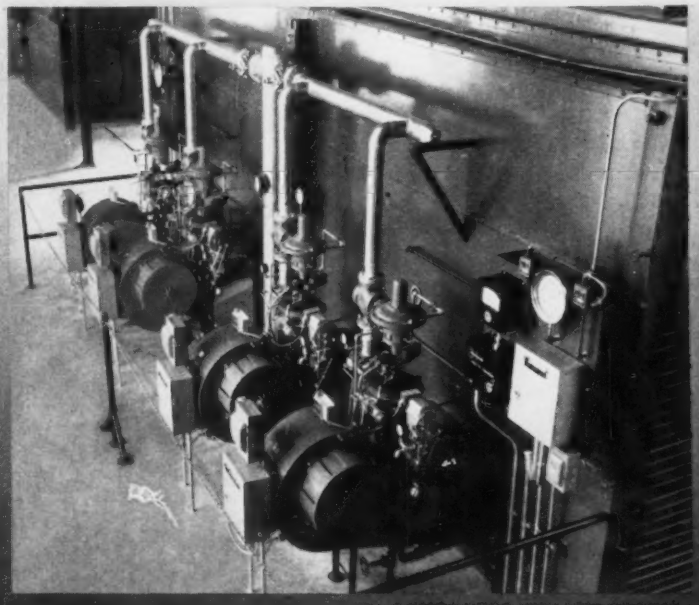
...with Mettler Gas Conversion Burners



Installation above, on two big power boilers in a college plant, typifies the performance obtained by using fully packaged automatic "Fan-Air" conversion burners to make old boilers perform like new.

The 375-bhp watertube four-drum units without superheat or water walls were installed in 1922. Thirty-five years later four new Mettler "Fan-Air" Burners enable the boilers to exceed original capacity and efficiency! Below, performance tests on one boiler show 79.05% over-all efficiency. Other boiler tested at 78.25%. The four burners yield 75,000,000 Btu input.

WRITE FOR DETAILS—Mettler "Fan-Air" gas or combination gas/oil burners come with automatic cycling preset to your requirements. You simply specify package for forced, induced, or natural draft, cataloged by inputs of 400,000 to 30,000,000 Btu/hr. BULLETIN G-200B gives full details on the features behind Mettler efficient burning and wide adjustability. Request copies today!

PERFORMANCE TEST ON BOILER No. 1 AFTER MODERNIZATION

Boiler	Fuel	Input	Stack Temp.	Ambient Temp.	Steam Press. Gage	Feed Water	Steam Flow	% Nominal Rating	Over-all Efficiency
B & W No. 1	Natural gas 940 Btu	40149 CFH 37832 M Btu	517°F	75°F	134.2	212°F	29523 PPH	228	79.05%

ALL TABULATED FIGURES ARE AVERAGES ON EACH RUN.

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My biggest boner

To "take it for granted" doesn't pay off in large generating stations. Don't believe that the other guy will do the right thing and finish a job that he's started. I did, and earned the nickname of "Boom Boom."

One boiler in a battery of five was out of service for cleaning and inspection. A gate valve had to be replaced on No. 1. To do so, No. 2 and 3 boilers had to be taken off the line. When job of replacing the valve was completed, this automatically made No. 2 and 3 boilers available for service again.

I was watertender on the west end of the boiler room where the boilers were unavailable. Now the east-end watertender started to help me clear up some jobs that were completed and being readied for service. That included No. 2 and 3 boilers. I took it for granted that he would complete the job. But he didn't open the main stop and nonreturn valves which I thought he did. So I marked them as being available in the daily log, stating that the main stop and nonreturn valves were open.

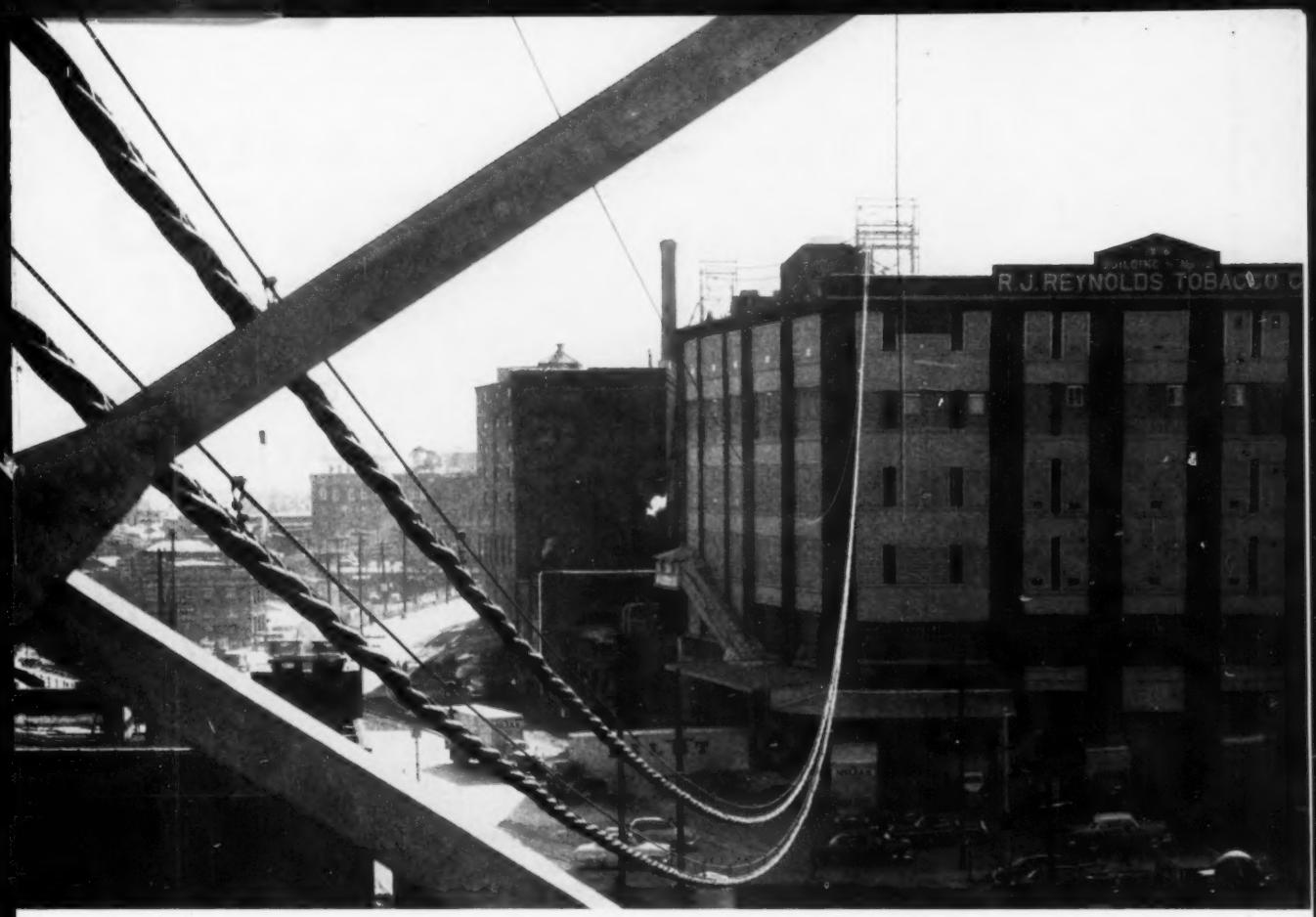
Next morning, when the boilers were lit off and brought up to line pressure, the safety valves started to blow. No one expected the main stop and nonreturn valves to be closed. I was off that day, but when I showed up next day, all the men started to call me "Boom Boom."

The supervisor didn't say too much, but that incident taught me to follow through, instead of assuming that some one did my work for me.

F A Turano, *Jersey City, N. J.*

Two-cycle engines meet municipal needs

Expanding power requirements of Russel, Kansas and Houma, La. have been met by purchase of Nordberg two-cycle Duafuel engines. The Russel engine, scheduled for installation by June 1958, is rated 4200 bhp at 257 rpm, will drive a 3000-net-kw generator. Houma's three engines, each rated 5250 hp, operate at 257 rpm; net rating of each attached generator is 3750 kw.



Okolite-Okoprene aerial cables furnish a low-cost route for increased power demands over a span of 420 feet between buildings.

More power the low cost way ...with Okolite-Okoprene aerial cable

To meet the power demands of increased cigarette production, The R. J. Reynolds Tobacco Company of Winston-Salem, North Carolina, recently installed the two Okolite-Okoprene aerial cables shown here. An operating voltage of 15kv and a span of 420 feet across two open primary lines and railroad sidings called for aerial cables with maximum reliability. Okolite-Okoprene self-supporting cable was used, with extra messenger for added safety.

Here is another case where an Okonite self-supporting aerial cable solved an increased power-demand problem simply and economically. The overhead route often costs much less than the underground route . . . and it can be just as safe, too, when you use dependable Okolite-Okoprene cable. Recommended for general use up to 35kv, Okolite-Okoprene is insulated by Okonite's exclusive strip process and (if rated at over 2kv) inspected inch-by-inch on the Gooding Test Train.

Okonite is the only manufacturer making cables by all insulating methods: strip, extrusion, tape or dip. Thus we are in the unique position of being able to recommend to you without prejudice the one cable which most closely meets your requirements. The Okonite Company, Passaic, New Jersey.

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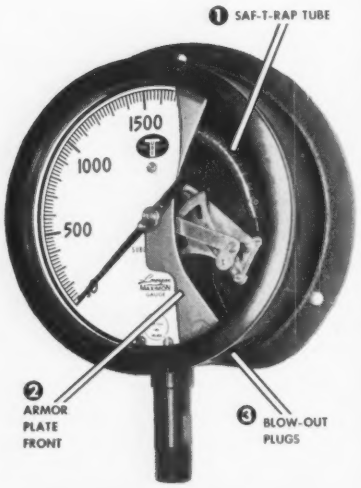

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1 New SAF-T-RAP Tube . . . special industrial tape wrapping which confines or smothers explosive effect when tube is ruptured.

2 New SAF-T-KASE places an armor plate between dial and tube and movement assembly—thereby containing any explosive force within the cast housing.

3 New BLOW-OUT PLUGS (Safety Vents) . . . provide positive insurance against any pressure build-up within the gauge . . . slightest pressure causes plugs to drop out.

Another big plus feature for new Lonergan SAF-T-RAP Gauges is *bored steel tubing*, carbon or stainless . . . a special machine *rifle bores* the tubes, producing a "mirror-like" finish which decreases the possibility of rupture and adds to the life of the gauge (it has been proved that tubes will often rupture at the point where there is a tool-score).

And, all of these features for greater safety and longer life are available with Lonergan SAF-T-KASE Gauge with SAF-T-RAP Tube. Write for further details.

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Philadelphia 6, Pa.

Technical briefs

Begins on page 152

(1) An oxide-fuel-element pressurized-heavy-water reactor fueled with natural uranium plus plutonium and using natural uranium feed. (2) A mixture of light and heavy water in pressurized-water reactors using either uranium or thorium. (3) A gas-cooled reactor (perhaps with suspended solids) having oxide or other ceramic type fuel elements. (4) For the long range, the sodium-cooled fast breeder using plutonium fuel, possibly ultimately in fluid form. (5) Also for the long range, fluid fuel reactors of several types.

The author feels it's very important to proceed with development of the plutonium and uranium-233 cycles. This means expediting development of commercial reprocessing to obtain some meaningful costs. The author also believes we should work toward using plutonium and uranium-233 in actual reactors, even if these aren't on a large scale. There are long-range advantages in using these fuels in fluid form and, despite the obvious difficulties, such use is a most worthy objective. *ASME paper, No. 57-PWR-9*

Pennsylvania Advanced Reactor: process description. *By S C Townsend, Pennsylvania Power & Light Co, W E Johnson and D H Fax, Westinghouse Electric Corp*

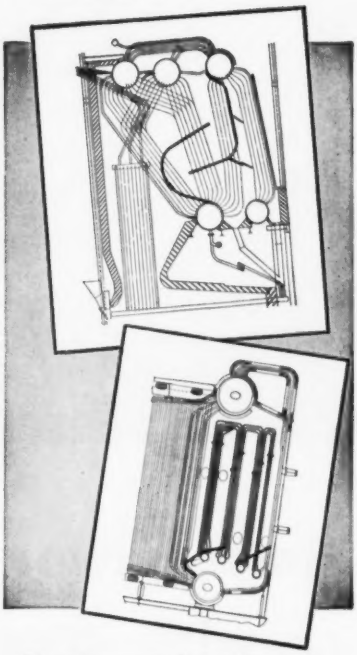
Development program of the Pennsylvania Advanced Reactor Project and concepts for remote maintenance of an activated plant have been reported in earlier papers. This paper presents details of the most recent process designs for the primary heat-removal system and principal auxiliary systems, including gas handling and disposal, fuel handling and chemical processing. Proposed start-up and shutdown methods, as well as steady-state operation, are described. *ASME paper, No. 57-PWR-13*

Enrico Fermi Atomic Power Plant status report, October 1957. *By J Anderson, Power Reactor Development Co*

Erection and initial pressure testing of the PRDC reactor containment vessel was completed on Oct 6. This building will house the APDA

Directions for ordering papers on page 194

ONLY ENCO BAFFLES give you all these COST CUTTING FEATURES



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- **Streamlined gas flow**
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Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.

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1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.

2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.

3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.

4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.

5. Sleeves carried on bearing rings, located on *transverse center line of hub spline faces* (the load-carrying surfaces) . . . no crank action, no vibration.

6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3301 Scott Street, Baltimore 3, Maryland.

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FOR ACCURATE MEASUREMENT OF STEAM CONDUCTIVITY

MOST modern and efficient system of removing volatile amines, ammonia and carbon dioxide prior to recording steam conductivity. This thoroughly effective steam degasser uses a cation exchange resin for the removal of ammonia, morpholine, cyclohexylamine, and reboiling for the removal of CO_2. Constant sample temperature is maintained. Taps provided for drawing sample for other analyses.

Larson-Lane Steam and Condensate Analyzers make possible rapid and accurate measurement of steam purity, completely essential for efficient boiler operation.

A smaller, less expensive unit, the CH-16 provides for removal of ammonia and amines from steam condensate without the necessity of reheating. Condenser leakage is readily detected with this model in the presence of volatile amines or ammonia.

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Industrial Instruments Inc.
89 Commerce Road, Cedar Grove, Essex County, N. J.

Technical briefs

Begins on page 152

test facility and the ultimate reactor. Piping erection will begin inside the containment vessel early in 1958.

Piles are now being driven for the sodium-handling facility, which is to be completed before Dec, 1958. Its purpose for both test facility and actual plant operation is threefold. It serves for sodium unloading, storage (45,000 gal) and purification.

Construction should start on the ventilating building during Jan 1958. This facility is designed to remove some 2,700,000 Btu per hr from the containment vessel during reactor operation.

Detroit Edison has completed most of the necessary site improvements and is constructing a plant-services building that will contain intake screens for condenser water, raw water-treatment units and temporary or standby space-heating units. Construction of the turbine-electric building will commence in April, 1958. *AIF paper, No. 57-AIF-53*

Lubrication

On friction and lubrication at temperatures to 1000 F with particular reference to graphite. *By E E Bisson, R L Johnson and W J Anderson, Lewis Flight Propulsion Laboratory*

High-temperature lubrication studies have been conducted in both sliding friction and small-scale rolling-contact bearing apparatus. Graphite effectively lubricated various metal combinations at 100 and 1000 F, but not at all intermediate temperatures. The generally accepted theory (that graphite lubricates because of adsorbed water or gaseous films) seemed incapable of explaining the results at 1000 F; therefore, a supplementary hypothesis is advanced.

It is hypothesized that effective lubrication is possible with graphite, provided either of two conditions is met (a) An adsorbed water or vapor film is present; or (b) an oxide film of the proper type is continuously present on one or both of the lubricated surfaces. The oxide film is believed to influence adherence of graphite to the surface.

Directions for ordering papers on page 194

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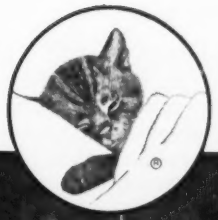

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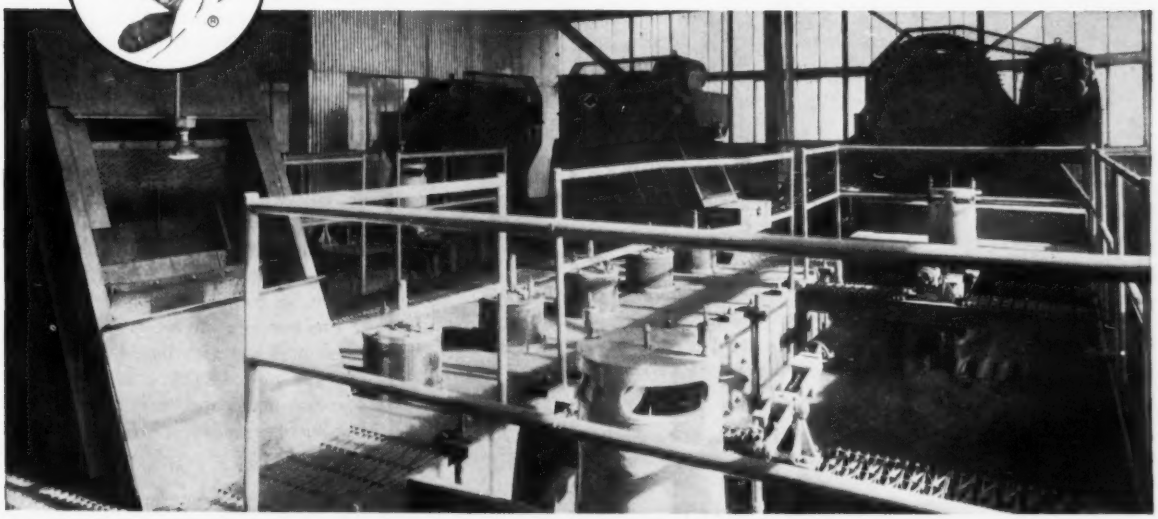


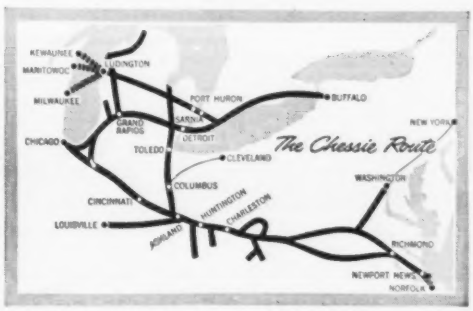
SUPERIOR COAL. The entire output of this mine is processed by automatic compound coal cleaning equipment. Producers on the Chesapeake and Ohio are prepared to supply you with highest quality coal of the type best suited to your needs and processed to your own specifications.

SUPERIOR SERVICE. With the world's largest fleet of coal cars, kept in better than 99% good order, Chesapeake & Ohio trains roll at top speed over a roadway specially designed and maintained for heavy coal haulage.

For dependable deliveries of top quality coals, contact coal producers on the C & O. And for specific help in meeting your own fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake and Ohio Railway Co., Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

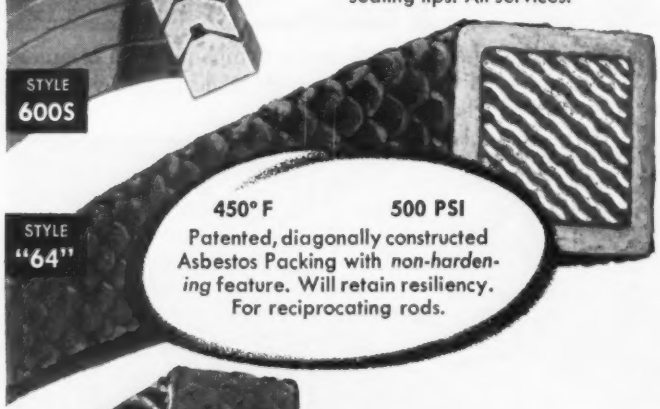


5 CHESTERTON PACKINGS expressly developed for STEAM

HEAT . . . . . PRESSURE

1000°F **2000 PSI**
A 95% pure asbestos braided yarn with monel wire insertion. Mica lubricated. For extreme heat and pressure service.

550°F **1000 PSI**
Improved self-sealing moulded Asbestos Packing with multiple feather sealing lips. All services.



450°F **500 PSI**
Patented, diagonally constructed Asbestos Packing with *non-hardening* feature. Will retain resiliency. For reciprocating rods.

350°F **125 PSI**
Soft, highly lubricated Asbestos Packing for medium to low pressure and fast moving shafts.

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Compressed Asbestos Sheet. Homogeneously constructed with complete graphite impregnation. Cuts easily. *"Lasts as long as the iron."*

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A. W. CHESTERTON CO. • EVERETT 49, MASS.
America's Oldest Manufacturer of Mechanical Packings

Technical briefs

Begins on page 152

Oxides or salts of soft metals were mixed with graphite to improve adherence of graphite to metal surfaces. Several mixtures provided effective lubrication at all temperatures from 100 to 1000 F.

Rolling-contact bearing studies were made with both liquid and solid lubricants under various atmospheres. Liquids were effective at temperatures to 850 F provided the oil-oxygen ratio was maintained appreciably greater than stoichiometric. MoS_2 was effective at 1000 F in nitrogen as compared to 850 F in air.

For temperature levels higher than those possible with liquid lubricants, gaseous lubricants capable of extreme pressure action in boundary lubrication have promise. *ASME paper, No. 57-LUB-1*

TO OBTAIN COMPLETE TEXT

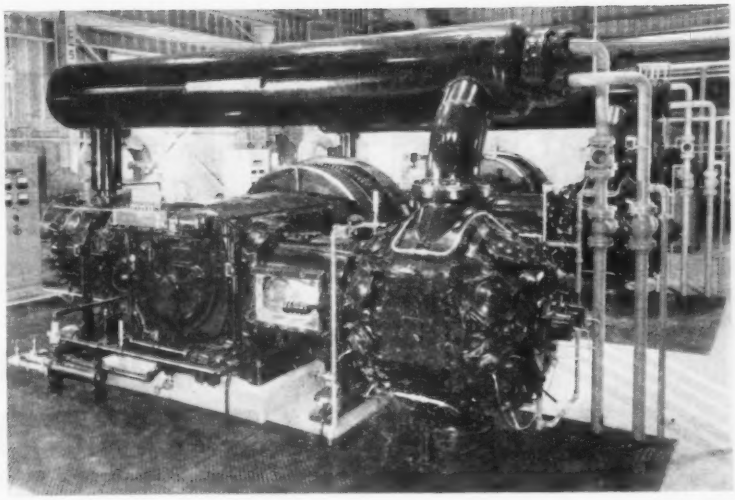
Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable from ASME, 29 W 39th St, New York 18, New York.

Atomic Industrial Forum, Conference on Management, Economics, and Technology for the Atomic Industry. Identified by initials AIF, and obtainable by purchase from AIF, 3 E 54th St, New York 22, N. Y.

Year's end roundup by Trane Co indicates that industrial air-conditioning for stepped-up efficiency is on the increase. Less than 1% of U.S. factory space is currently air conditioned, but many architectural-engineering firms now recommend installation or provision for future installation on all new plants.

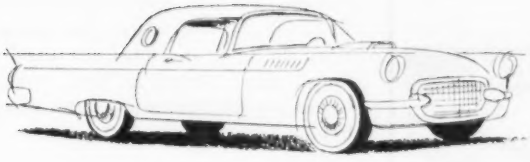
Martens H Isenberg, president and director of Combustion Engineering, Inc, and associated with the company for 41 years, has resigned because of ill health. H G Ebdon, executive vice-president, was elected president and a director, and Arthur J Santry Jr was named vice-chairman, the company announced.



Cooper-Bessemer JM's *with 5-step automatic unloading in the Rawsonville plant of Ford Motor. Note the windows to observe crosshead action within compressor.*

Cooper-Bessemer industrial air compressors

...helping build the "Ford in Your Future"



Here in the Accessory and Hardware Division, Manufacturing Plant of the Ford Motor Company, Rawsonville, Michigan, two Cooper-Bessemer JM compressors furnish compressed air for general factory and production facilities.

The rugged construction and dependability of these 2-cylinder motor-driven compressors, each rated 600 hp at 300 rpm, assures trouble-free service for many future years. Extreme compactness reduces foundationing and needed floor space, saving installation time and cost. Natural force balance contributes to vibration-free operation and lower maintenance. Find out for yourself how Cooper-Bessemers economically answer every plant air problem.

Motor-driven, turbine-driven, engine-driven . . . Cooper-Bessemer M-Line compressors are available in sizes from 200 to 6,000 horsepower and for pressures to 15,000 and vacuums.

Write for your free *copy of the NEW 44-page Industrial Air Bulletin M-81. Address The Cooper-Bessemer Corporation, Mount Vernon, Ohio.*

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The modern TUBE CLEANER

Fast • Powerful • Efficient

Only ROTOJET Tube Cleaners offer the simple, efficient, time-tested Rotocentric design. A single paddle maintains contact with the cylinder wall without depending upon centrifugal force. Motor won't stall at low speeds caused by heavy loads. Positive starting is assured with Rotojet motors driven by air or steam.

Rotojet water-driven Tube Cleaners are comparable in speed and power with air-driven types.

Send for bulletin showing motors, heads, and brushes for straight and curved tubes and pipes from ½" to 12" I.D.

Section of ROTOJET pneumatic motor showing simple design.

PNEUMATIC

Model C-525 ROTOJET Air-driven Motor with swing-frame head and universal coupling for 2¾" to 3½" I.D. curved tubes.

Model S-530 ROTOJET Air-driven Motor with swing-frame head for 3¼ to 3-13/16" I.D. straight tubes.

Model C-526 ROTOJET Air-driven Motor with single pin head and universal coupling for 1¾" to 2½" I.D. curved tubes.

Model C-434 ROTOJET Junior Air-driven motor, flexible holder, expanding brush.

HYDRAULIC

Model C-322 ROTOJET Water-driven Motor with 3-arm head and universal coupling for 2¼" to 2½" I.D. curved tubes.

Model S-360 ROTOJET Water-driven Motor with combination drill head and universal coupling for 3¼" to 3⅞" I.D. straight tubes.

Model C-321 ROTOJET Water-driven Motor with short 4-arm head and universal coupling for 2½" to 3" I.D. curved tubes.

ELLIOTT COMPANY – ROTO PLANT
DIVISION OF CARRIER CORPORATION
Tube Cleaner Specialists Since 1910
153 Sussex Avenue, Newark, N. J.

Lubrication

Continued from page 123

changed to the new lubricating oil.

Well, they got more capacity, but at what a price! In a cement plant with limestone dust blowing all around, and with the intake located in a dirt-floor basement, they surely needed all the air filtering they could get. Abrasive material carried by the air wears the moving parts of a compressor and collects on the oil-wet exhaust valves.

The oil serves as a binder and continued exposure to high temperature forms a hard deposit. This is difficult to detect from that which is formed by inferior compressor oils, except with an expensive laboratory analysis. Should the deposits be heated to incandescence, they could set the stage for a potential air-compressor fire or explosion.

I recommended overhauling the lubricator and adjusting the feeds so each end of the l-p cylinder received 8 to 12 dpm and the h-p cylinder received 6 to 10 dpm. This was slightly less oil than they had consumed before, but it was better distributed. Until the filter and lubricator conditions were corrected, they could expect similar trouble no matter what kind of oil they used.

Condensers

Continued from page 85

overloaded but pump handles more water than the design calls for, it is usually best to make no changes. Benefits gained because of the improved vacuum outweigh the extra pumping power used. If condensing water is very cold, vacuum gain is less and improvement in heat rate of turbo-generator at a high vacuum may be so small that it will not pay for the extra pumping power used.

Where circulating pumps have variable-speed drive or are in multiple so water flow may be reduced, it is often economical to reduce condensing-water flow in cold weather and at partial loads. If the only means of lowering water flow is by throttling pump discharge valve, pump-power saving is small, probably less than turbo-generator loss in output.

If pump uses too much power and condensing water flow is above normal, slightly reducing diameter of pump rotor cuts power considerably

COMPLETE LINES OF WALWORTH VALVES for POWER PLANT SERVICE

Featuring Walworth Pressure-Seal Valves

Here are cast steel valves built for high-pressure, high-temperature service. The unique bonnet-to-body design utilizes internal line pressure for a tight, leakproof connection. The higher the pressure the tighter the bonnet joint! Bulky, heavy bonnet flanges, bonnet studs, and nuts are completely eliminated providing a modern valve design of truly streamlined proportions. Maintenance is simplified as Walworth Pressure-Seal Valves are easily assembled, disassembled, and insulated.

Walworth Pressure-Seal Valves are available in Series 600, 900, 1500, 2500, and in a wide range of sizes and types. Complete information is available from your nearby Walworth Distributor—or—write Walworth for for a free copy of Circular 16.

and including these valves for "*'round-the-plant*" use!

WALWORTH SMALL CAST STEEL Y-GLOBE VALVES. Simplified design eliminates many of the problems encountered in high-temperature, high-pressure service. No bonnet joint. Improved back-seat design means longer life for packing rings.

WALWORTH LUBRICATED PLUG VALVES. Easy turning—quick operating. Lubricant can be renewed while the valve is in service. Lubricant completely surrounds the plug ports for a tight seal against leaks. Remember, always use Walworth Lubricant in Walworth Lubricated Plug Valves.

WALWORTH BRONZE VALVES. Standardized lines of bronze valves provide an unsurpassed system of interchangeability of parts, drastically reducing inventory problems. Walseal Valves with brazing ends also available in a variety of types.

WALWORTH IRON BODY GATE VALVES. Straight-flow port design reduces fluid turbulence to a practical minimum. Seat rings of end-seated type are screwed into the body. Brass liner on glands assures greater resistance to corrosion and scoring. Available with threaded or flanged ends.

WALWORTH CAST STEEL GATE VALVES. Bolted bonnet, wedge gate, OS&Y. Bonnets and bodies are engineered to withstand pressure and minimize distortion. Heavy steel walls provide extra strength and longer life. Deep stuffing boxes in all sizes (2" to 24") insure tightness and maximum packing life. Also available in globe and angle types.

WALWORTH also offers Plastic Valves, Fittings, and Pipe of polyvinyl chloride.

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Walworth Company of Canada, Ltd., Toronto

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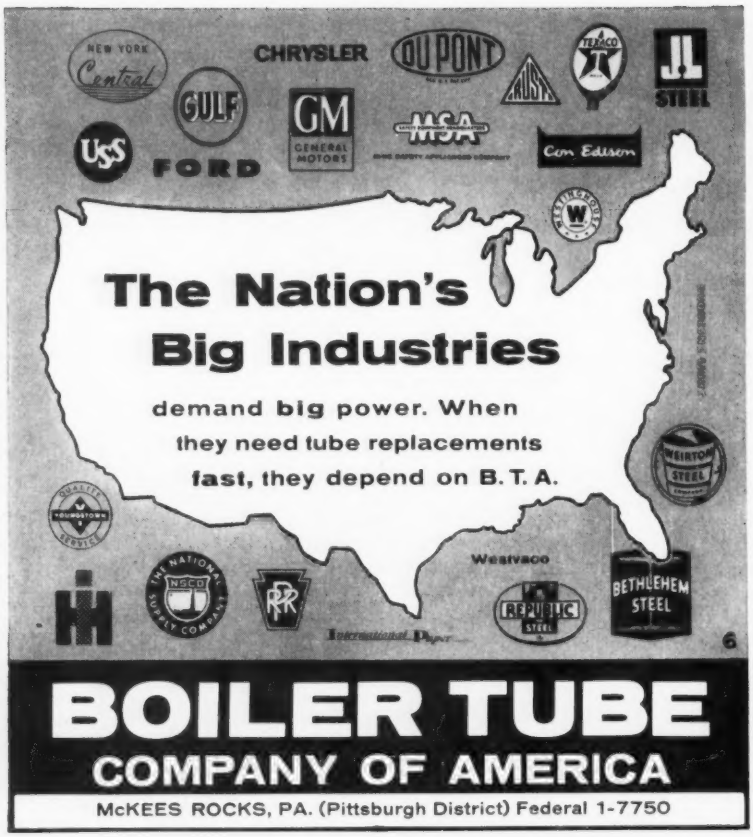
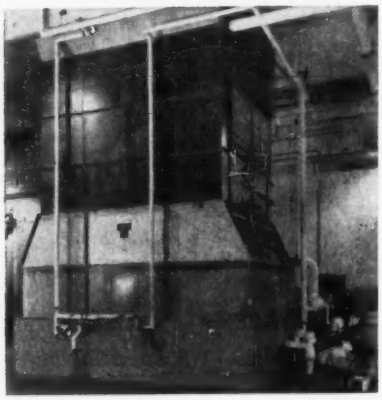


WHEREVER YOU NEED TO COOL A FLUID... and have a problem of water supply or disposal... use NIAGARA "AERO" HEAT EXCHANGER



▶ Evaporating a very small amount of water in an air stream you can cool liquids, gases or vapors with atmospheric air, removing heat at the rate of input, controlling temperature precisely. Save 95% of the cost of cooling water; save piping, pumping and power. You quickly recover your equipment cost.

You can cool and hold accurately the temperature of all fluids, condense vapors, cool water, oils, solutions, intermediates, coolants for mechanical, electrical or thermal processes. You have a closed system free from dirt. You have solved all problems of water availability, quality or disposal, maintenance expense is low.

You may apply this to solvent recovery, vacuum systems controlling reactions, condensing distillates, cooling reflux products.

For more information, write for Bulletins 120, 124, 135. Address P-1

NIAGARA BLOWER COMPANY
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Niagara District Engineers in Principal Cities of U. S. and Canada

Condensers

Continued from page 196

without affecting water flow too much. Give the manufacturer data on pump performance and ask for change recommendations. A 5% reduction in diameter is about the safe maximum decrease. This lowers pump head to about 90% of its previous value.

If condensing-water circuit head loss comes mostly from friction, flow would be reduced about 5% so power reduction would be close to 15%. If a considerable portion of the system head loss is static head, for instance where water is pumped over a cooling tower, a greater flow reduction must occur before system head loss equals pump head. Analyze pump and system carefully, therefore, before reducing impeller diameter. It is preferable to make the reduction in several steps, observing the effect of each change before proceeding further.

Vertical pumps may take a number of forms. The volute type has a rather flat characteristic head-flow curve, similar to a horizontal volute pump. Power used increases with flow, to well past rated pump capacity. At the other extreme, propeller-type pumps have very steep head-flow curves, and pump power decreases with flow. The axial-flow pump is in between, with a nearly flat head-flow curve, so difficulties from excessive power required when starting against a closed shut-off valve are avoided.

Vertical-pump suctions must be well submerged, at least several ft below water surface. This avoids formation of eddies that permit air to be drawn into the pump, reducing its capacity. Even if pump is well submerged, there must be ample room beneath and all around pump suction, so water enters evenly and at low velocity. High-velocity spins and swirls at pump inlet may seriously reduce capacity and efficiency even if air is not entrained.

Before starting vertical pumps for the first time carefully check for alignment and lubrication. Packing should be in place with stuffing-box bolts slacked off and sealing-water supply ready for use. Some pumps use water for lubrication; be sure that supply lines have been flushed out and that a clean supply of water at adequate pressure is available for the bearings. (*Continued on p* 200)

HOW TO SELECT WATER-CONDITIONING EQUIPMENT (NO. 6 OF A SERIES)

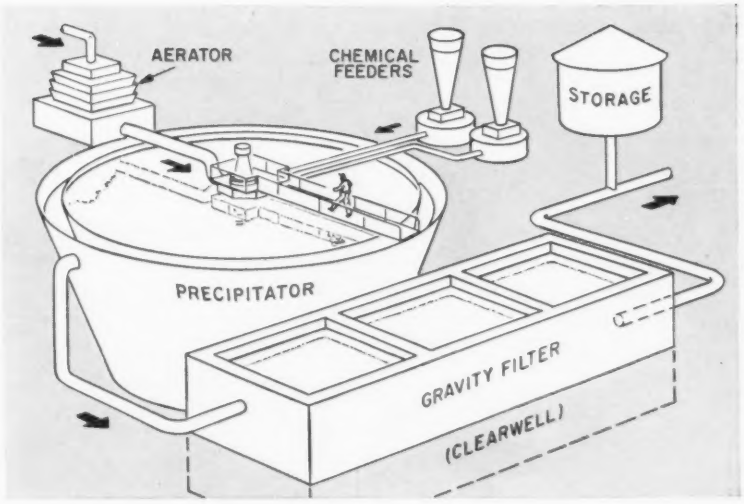
Typical Water-treatment Systems

These factors are involved in selecting types and sizes of equipment for a specific use: Analysis of the raw water, volume and quality of water required, initial and operating cost of equipment, rate of amortization and future expansion possibilities. Typical systems illustrating widely varying requirements:

Treating a well water for a municipal water supply

(or as pretreatment for demineralizing)

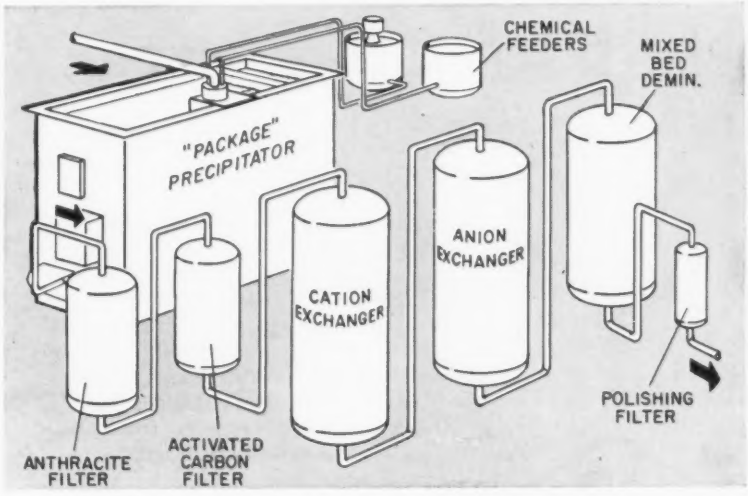
Aerator reduces CO_2 . . . to lower acidity. It also reduces taste and odor and oxidizes any dissolved iron or manganese. **Precipitator,** depending on the chemicals used, removes turbidity, color, hardness and oxidized iron and manganese. **Gravity filter** removes remaining traces of turbidity from Precipitator effluent.



Treating a process water used in manufacturing electronic components

"Package" Precipitator removes the bulk of the turbidity, hardness and iron. **Anthracite filter** removes remaining suspended matter from precipitator effluent. **Activated carbon filter** removes color and absorbs dissolved organic matter. **Demineralizer** (cation, anion and mixed-bed units) reduces dissolved solids to a very low, guaranteed maximum. **Polishing filter** removes traces of suspended matter from demineralizer effluent.

NOTE: Reprints of this series of advertisements, "How to Select Water-Conditioning Equipment," are recommended as a handy "short course" for students and engineers. A set of reprints will be sent free, on request.

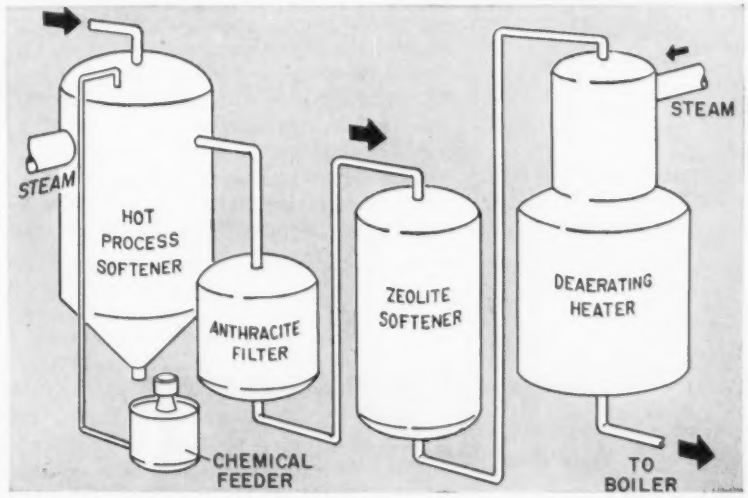


Treating water for a steam boiler

(For high-pressure-boiler feedwater treatment, see "9 ways to demineralize water by ion exchange".)

Hot-process softener reduces hardness to a few grains per gallon. It also reduces silica. **Anthracite filter** removes remaining turbidity from the effluent of the hot-process softener. **Zeolite softener** may be added where zero hardness is required. **Deaerating heater** removes oxygen to prevent corrosion.

For general recommendations on any type of water problem or equipment for its correction, write The Permutit Company, Dept. P-1, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.



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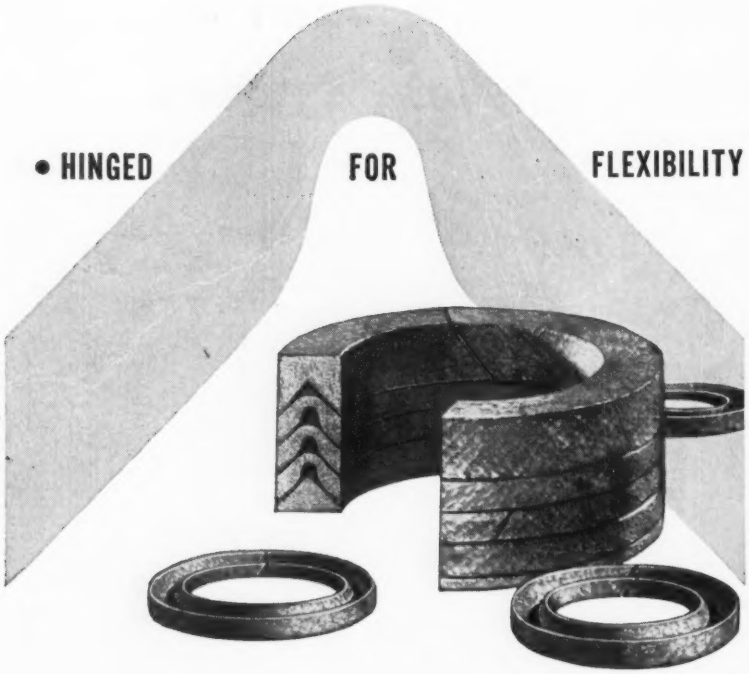
Ion Exchange • Industrial Waste Treatment



BELL-SHAPED V-Design makes BEL-VEE PACKING *pressure sealing*

Scientifically designed to make the pressure seal itself, Bel-Vee Rings expand toward the rod and stuffing box wall, with increased pressure, to automatically form the seal. Then when pressure is relaxed, Bel-Vee Rings contract from the rod for free movement with minimum friction.

That is why Bel-Vee Ring Packing keeps equipment running smoothly—cuts maintenance—lasts longer.

Offered in sets for pressures to 6000 psi for sealing reciprocating rods of pumps, engines, compressors, hydraulic equipment and valve stems.

Bel-Vee Rings are individually molded in practically every rod and stuffing box size, and in a number of basic material combinations for use against water, oil, solvents, steam, air and gas. Catalog No. 56. Also available in du Pont Teflon for all-chemical service. Catalog T-57.

ask your BELMONT Distributor

Such leading Packing Distributors as:

Warren & Bailey in Los Angeles

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Speck-Marshall in Pittsburg

are ready to supply your emergency as well as regular requirements.

The Belmont Packing and Rubber Company
Butler & Sepviva Streets, Phila. 37, Pa.

BELMONT

Condensers

Continued from page 198

Pump suction, suction chamber and inlet connections should be carefully cleaned out and inspected to assure against damage from debris. Be sure that inlet screens are in place and in operating condition. Try out shutoff and control valves in the circulating system to be sure they are operable. Check the entire system for unclosed openings, steel pipe-joint bolts that are not in place, not tightened, etc. Set valves for proper flow through the system, and close the pump discharge valve. If pump has a very steep head-capacity curve, you may have to leave this valve about ¼ open.

If possible, turn pump by hand to see that it moves freely. If this is impractical, "bump" motor several times to see that pump is free before actually running it. Before opening discharge valve wide, see that system is full of water and that there are no leaks.

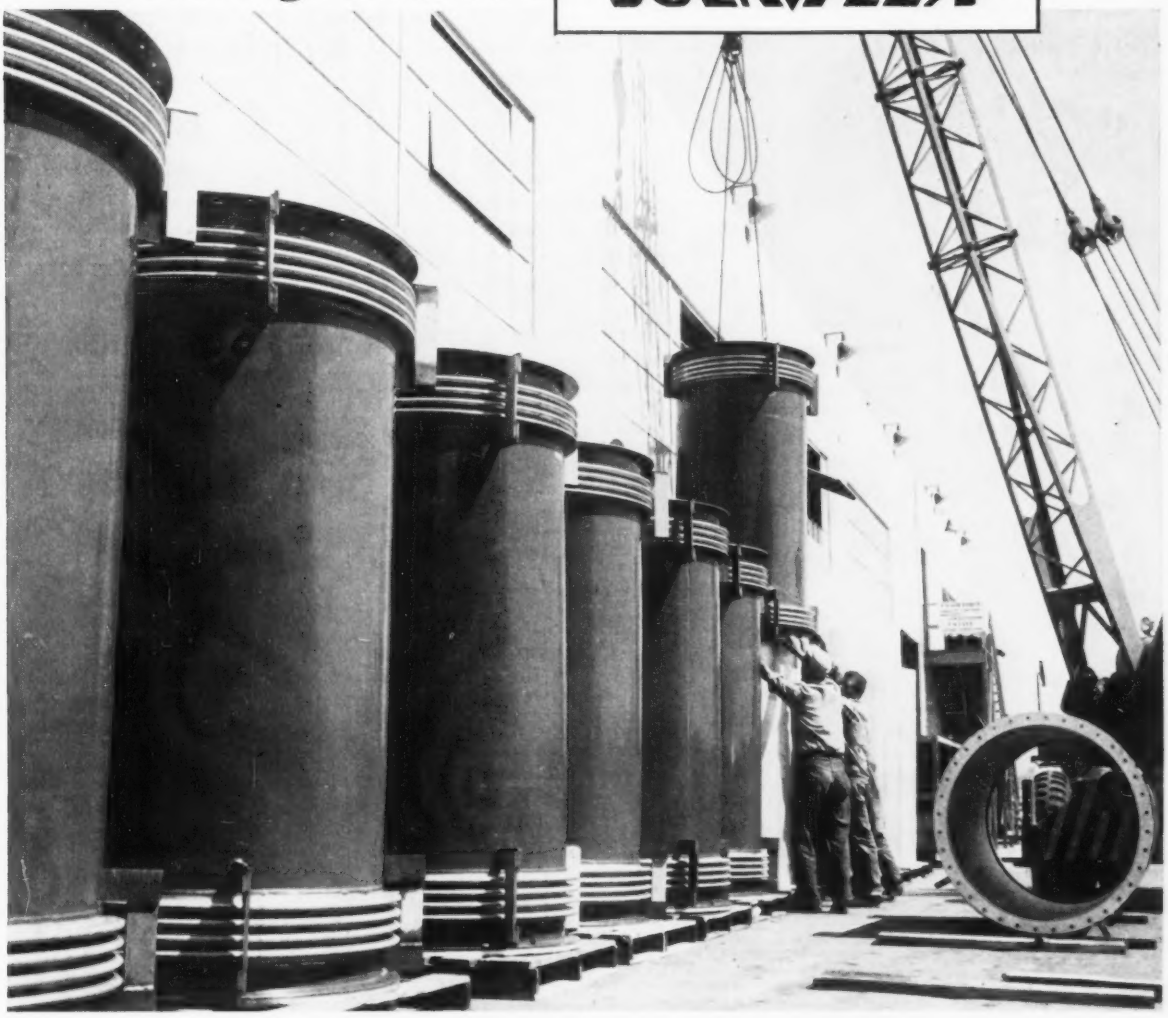
Then gradually establish full flow, and check pump-motor current against its rated current. Unfortunately, throttling pump discharge gives little or no reduction in motor current with this type pump. If motor is seriously overloaded, internal pump adjustments are needed. As soon as possible, check initial performance, including net pump head, approximate water flow and motor power input. This gives a check against design and manufacturers' test data, and provides a reference point for future periodic checks on performance. If performance remains essentially the same, all is well within the pump.

To inspect a vertical pump, lift it straight up, high enough to clear the casing. If pump is laid down, handle carefully to avoid springing the shaft. This is a very real hazard if the shaft is long. Special rigging may be advisable to support the center of the shaft as pump is laid down and picked up.

The many different types of vertical-pump design make it impossible to give details for inspection and repair. If impellers are pitted or worn away from original shape, they may be repaired or rebuilt. If wearing rings are worn, they may be replaced. Condition of bearing-lubricating system and packing wear sleeves

(Continued on page 202)

Leading firms use SOLA-FLEX®



Giant Sola-Flex joints used by Koppers in Weirton Steel plant

MORE AND MORE LEADING FIRMS—power, petro-chemical, nuclear and others—rely on custom-engineered Sola-Flex expansion joints to help solve difficult pressure and temperature problems. This giant shipment, being fitted with ½ in. heavy-gage removable liners, will be used in a windbox ducting installation designed by Koppers Company, Inc., for Weirton Steel's West Virginia plant. The joints will take up misalignment between main duct and ovens.

Solar manufactures the most comprehensive line of bellows and expansion joints in the world. They are made from a wide variety of stainless and high alloys that are *right* for important nuclear, missile and industrial applications—in sizes ranging from ½ in. to 35 feet in diameter. They are built for service from −320 F to 1200 F. And they tame "hard-to-handle" pressures up to 3500 psi for special applications. A new pamphlet describes Solar's complete line of Sola-Flex bellows and expansion joints. Write for it to Dept. D-132, Solar Aircraft Company, San Diego 12, California.

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SAN DIEGO
DES MOINES

DESIGNERS, DEVELOPERS AND MANUFACTURERS *of gas turbines, expansion joints and aircraft engine, airframe and missile components.*

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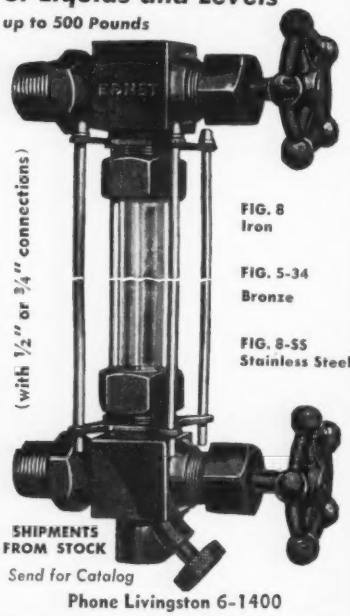
Gages for the Observation of Liquids and Levels

up to 500 Pounds



(with ½" or ¾" connections)

FIG. 8 Iron

FIG. 5-34 Bronze

FIG. 8-SS Stainless Steel

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Condensers

Continued from page 200

should be determined and necessary corrections made.

Trash protection. One or more heavy grills or screens are ordinarily used ahead of the circulating-water pumps to protect them against floating or submerged objects. A coarse bar screen or rack is used; this is placed at the lake or river side of the intake. Material accumulated on the rack is removed manually with long-handled rakes or with special power-operated rakes.

Where large quantities of floating material may appear unexpectedly—as after a flash flood—handling the material collected may be a serious problem. Trash screens should be removable for inspection and maintenance. Installing screens with a small slope—say 5 deg from vertical—expedites screen inspection and trash removal and handling.

Floating log booms keep logs and other large surface debris away from trash racks. This material lodges against the log boom which is anchored a few ft outside the trash racks. A change in wind direction usually makes the accumulated material float away. The boom may be constructed of several logs set one on top of the other to make a deeper, more effective obstruction.

Another successful trash-protection device is a series of nozzles placed along one side of a water header so as to form a water screen across the front of the trash rack. Service water or a special pump supplies water for this hydraulic trash repeller.

Trash screens. One or more fine screens in series are usually installed behind the coarse trash rack to catch smaller material such as leaves, weeds and fish. These might not damage the pumps, but would plug up the condenser tube ends. Two fine screens in series allow cleaning one screen while the other is in service. Trash baskets attached to the bottom of the screen catch the material held against the screen by the water flow as screen is raised, usually by a hoist. A high-pressure stream from a water hose usually removes material clinging to the screen, and the trash baskets are then cleaned by hand.

Where water contains considerable amounts of fine material, you might need almost continuous washing, and screens might even plug up fast

Just Out

Engineering Materials Handbook

Gives answers to both routine and specialized questions regarding the choice of engineering materials. Considers materials from the viewpoint of engineering structures, machinery, and equipment, and includes technical tables, design information, structural characteristics, etc. Emphasis is placed on the fabricated forms of materials, their physical and mechanical properties, adaptations, etc. **Ed. by Charles L. Mantell, Consulting Eng.; Newark College of Engrg. 1906 pp., 648 illus., $21.50**

Maintenance Engineering Handbook

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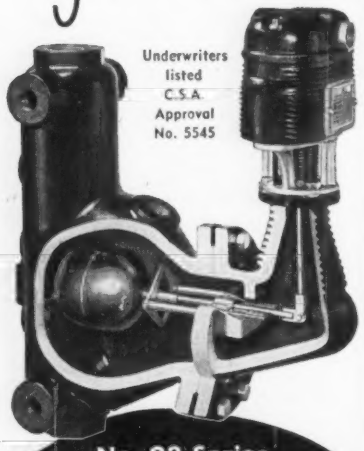

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Condensers

Continued from page 202

enough to cause a considerable level difference across them. This would make removal difficult and the heavy hydraulic pressure might damage the screen. Traveling fine screens used ahead of or in place of the stationary fine screens help avoid these troubles.

Traveling screens consist of a series of screen panels mounted on a chain and hinged together. These panels travel over a drive pulley at the top and downward into the water flow behind the front screen panel. At the bottom of the intake opening, they pass around an idler pulley and seal plate, then move upward again toward the drive pulley. They are then on the front side of the screen frame to catch trash in the incoming water. Lips of shallow baskets lift heavier trash out of the water.

A short distance below the upper pulley a series of sluice nozzles using high-pressure water and located just behind the front screen remove trash from the screens and trash lips. The debris flows into a sluice trough that carries it off to waste on land or down river from the plant.

The cleaned screens then pass over the drive gear and down the rear side of the screen frame. The front and rear panels run in guide channels that keep the screens aligned.

Screen panels should, of course, be intact. Cracks around screens and between screen and guide frame should not be excessive. Openings should be no larger than necessary for clearance. Washing nozzles must be properly aligned and of sufficient number for complete cleaning. Water pressure used and type of material deposited on the screens affect the cleanliness achieved. Material that is not knocked off by the wash jets is carried over the drive pulley and down the rear side of the screen where it is washed off by the condenser water and will probably accumulate on the condenser tube sheet.

Traveling screens often have multiple speed drives so speed can be adjusted to the amount of debris to be handled. Drop across the screens should be kept low; one ft is probably a reasonable maximum. The differential across screens can be used to warn of plugged trash racks and the need for fine-screen cleaning or traveling-screen operation. You need a rather sensitive mechanism to "feel"

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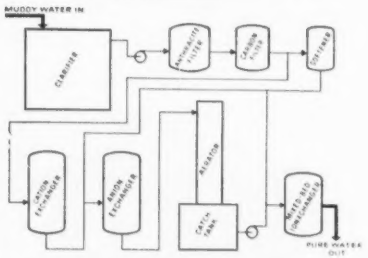

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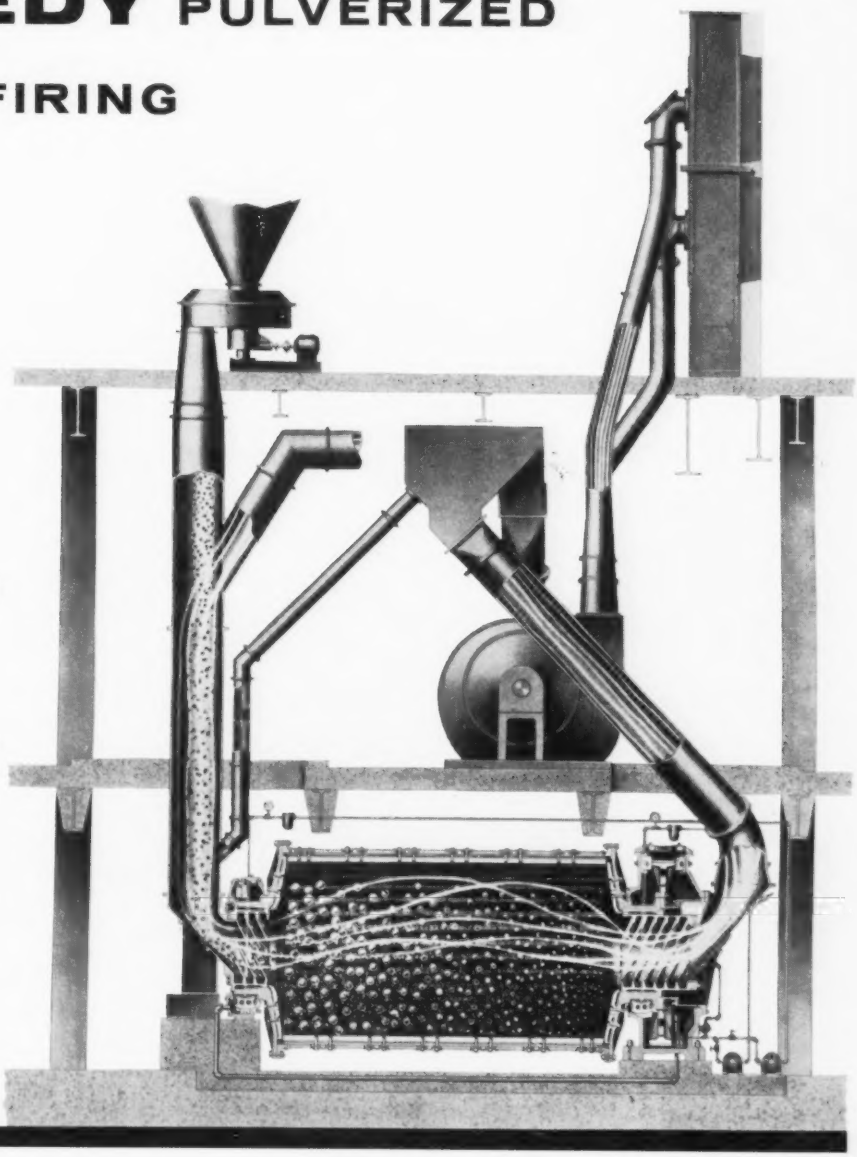

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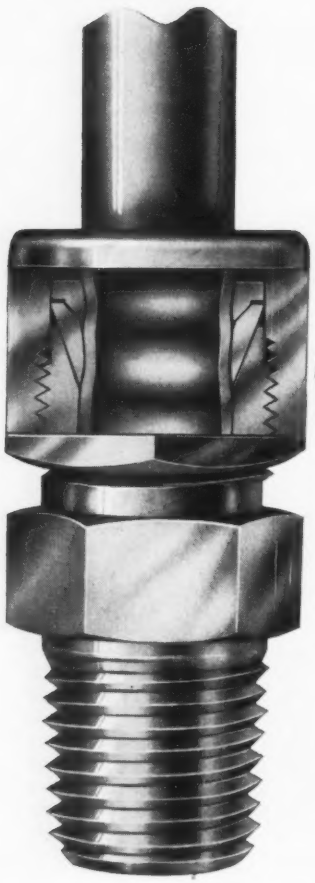

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Condensers

Continued from page 204

the level differences which may be only a small part of the total head variation caused by tides or water-level changes.

In cold climates the water may be subcooled below freezing. Needle ice may form on the screens and rapidly plug them. One solution is a recirculating line that mixes a portion of the condenser outlet water with the incoming cold water. This recirculating line should be opened when inlet water approaches 32 F. However, this does not help much against floating ice in the water, which acts more like floating debris. Compressed air delivered to one or more perforated pipes set in front of and below the intake screens may be effective in preventing ice formation.

The circulating-water intake should be set low enough to give ample water flow area below the ice cover that may form on a lake or river.

Free literature

Begins on page 163

and tower-wood deterioration, outlines program of treatment. Betz Laboratories Inc, Gillingham & Worth Sts, Philadelphia 24, Pa.

12 **Demineralizers** are discussed in 8-p technical bulletin 108-A. Illustrates valve and control arrangements, contains flowchart drawings. L-A Water Softener Co, 1007 Air Way, Glendale, Calif.

13 **Water purification** equipment is described in 6-p illustrated folder. Lists deionizers, demineralizers, dealkalizers. H M Mueller Corp, 3340 Gorham Ave, Minneapolis 26, Minn.

14 **Hotwater softeners** are subject of 24-p bulletin. Contains section on conditions requiring treatment, describes equipment. Drawings show tank designs. Cochrane Corp, 17th St & Allegheny Ave, Philadelphia 32, Pa.

15 **Zeolite water-softening** units are treated in 6-p illustrated bulletin 28B7107A. Contains diagrams, specs. Allis-Chalmers Mfg Co, Milwaukee 1, Wis.

PUMPS

16 **Standard screw pumps** are described in 6-p bulletin S-206. Features double-external bearing and gear, double-external bearing and gear hopper types. Contains diagrams, dimension table. Warren Pumps Inc, Warren, Mass.

(*Continued on page 208*)

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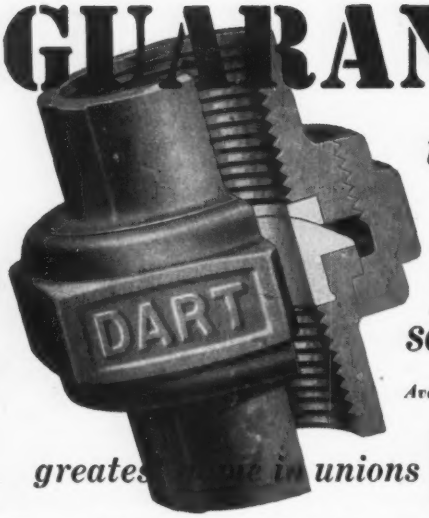

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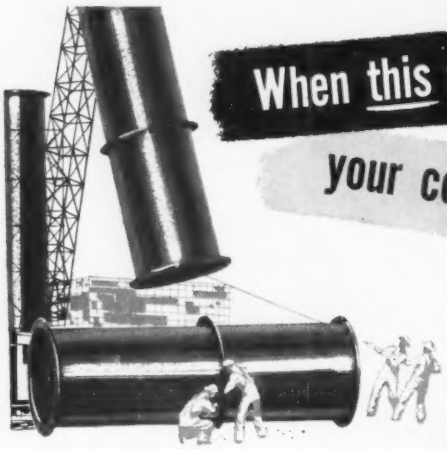

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Free literature

Begins on page 163

17 **Sand, slurry pump** is described in 4-p bulletin 601. Gives specs, cross-sectional view, construction details and parts list. Krogh Pump & Equipment Co Inc, 515 Harrison St, San Francisco 5, Calif.

18 **Sealed-gear pumps** are subject of 2-p technical reference TR-57D. Contains photos, drawings, details on discharge rates, speeds, valves. Bijur Lubricating Corp, 151 W Passaic Ave, Rochelle Park, N. J.

PRIME MOVERS

19 **Stationary diesels** are shown in 12-p illustrated bulletin 110. Lists low-speed power engines for continuous heavy-duty service. Gives dimension data, performance curves, specs. White Diesel Div, The White Motor Co, 1493 Sheridan Ave, Springfield, Ohio.

20 **Turbine drives** for boiler-feed pumps are subject of 16-p bulletin GEA-6541. Lists units for steam-electric generation stations of 150,000 kw and up. Graphs, diagrams included. General Electric Co, Schenectady 5, N. Y.

21 **Synchronous generators** for hydroelectric power generation are described in 24-p illustrated brochure PB 2800-1. Has sections on stator and rotor construction. Contains photos, diagrams. Elliott Co, Jeannette, Pa.

★ **Free-piston engines** are discussed in 36-page illustrated booklet. Gives detailed specs, performance data for each model. ★Request direct on company letterhead. Hamilton Div, Baldwin-Lima-Hamilton Corp, Hamilton, Ohio.

BOILERS AND AUXILIARIES

22 **Packaged boilers,** oil- and gas-fired, are subect of 16-p catalog. Contains installation photos, cutaways, dimension sheets for units of 35 to 500 hp, 15 to 150 psi. Dominion Bridge Co, Lachine, Que, Canada.

23 **Feedwater heaters** are discussed in 16-p bulletin 300. Outlines uses, design problems. Contains illustrations, diagrams. The Griscom-Russel Co, Massillon, Ohio.

PIPING, VALVES AND FITTINGS

24 **Ductile iron valves** are described in 6-p folder. Gives specs on metal and valves, lists models. Kennedy Valve Mfg Co, 572 E Water St, Elmira, N. Y.

25 **Lace-on covering** for pipes is described in 4-p illustrated bulletin. Contains specs, application data, finishing details. Forty-Eight Insulations Inc, Aurora, Ill.

26 **Valve controls** are discussed in 6-p bulletin 4-57. Gives ratings, photos, diagrams. Philadelphia

Gear Works Inc, Erie Ave & G St, Philadelphia 34, Pa.

27 **Dielectric values,** power factor and volume resistivity of polyvinyl chloride pipe is discussed in 30-p catalog. Classifies corrosion - resistance ratings; contains tables, installation data, specs. A M Byers Co, Clark Bldg, Pittsburgh, Pa.

28 **Liquid-level gages** and valves are described in 8-p catalog 305. Illustrates standard- and special-function units, gives dimensional drawings, graphs and ratings. Jerguson Gage & Valve Co, 80 Adams St, Burlington, Mass.

AIR CONDITIONING HEATING AND VENTILATING

29 **Steam heating coils** for heavy-duty service are subject of 12-p illustrated booklet 1715. Gives selection data, suggested piping arrangement, diagrams and descriptions. Westinghouse Sturtevant Div, Dept T-401, 200 Readville St, Hyde Park, Boston 36, Mass.

30 **Steam distributing coils,** double-tube type, are subject of 8-p catalog B-1418. Gives specs, installation drawings, piping diagrams. American Blower Div of American Standard, Tireman Ave at Roselawn, Detroit 32, Mich.

31 **Oxycat systems** for air-pollution control and heat recovery are described in 8-p illustrated bulletin. Features four case histories, illustrates systems available. Industrial Div, Oxy-Catalyst Inc, Lancaster Pike, Wayne, Pa.

32 **Oil heaters** are treated in 4-p illustrated folder. Shows internal construction of coil-type design, includes specs. Bros Inc, 1057 10th Ave SE, Minneapolis 14, Minn.

33 **Dual-duct air mixing** units are subject of 8-p bulletin DD-4. Includes photos, details, dimensions. Buensod-Stacey Inc, 45 W 18th St, New York 11, N. Y.

COMPRESSORS AND ACCESSORIES

★ **Air compressors,** 1/3 to 20 hp, are subject of 32-p illustrated booklet. Contains data charts, specs. ★Request direct on company letterhead. The Wayne Pump Co, Industrial Div, Ft Wayne 4, Ind.

34 **Water evaporators** are described in 8-p illustrated brochure. Lists vapor - compression apparatus, flash evaporator, centrifugal compression stills. Gives models, capacities, flowsheets. Evaporator Div, Badger Mfg Co, 230 Bent St, Cambridge, Mass.

ELECTRICAL EQUIPMENT

35 **Batteries,** from theory to maintenance, are covered in 44-p bulletin GB-1599A. Diagrams, tables review battery theory and construction, demonstrate selection, testing. Gould-National Batteries Inc, Stone & Calhoun Sts, Trenton 7, N. J. (*Continued on page* 210)

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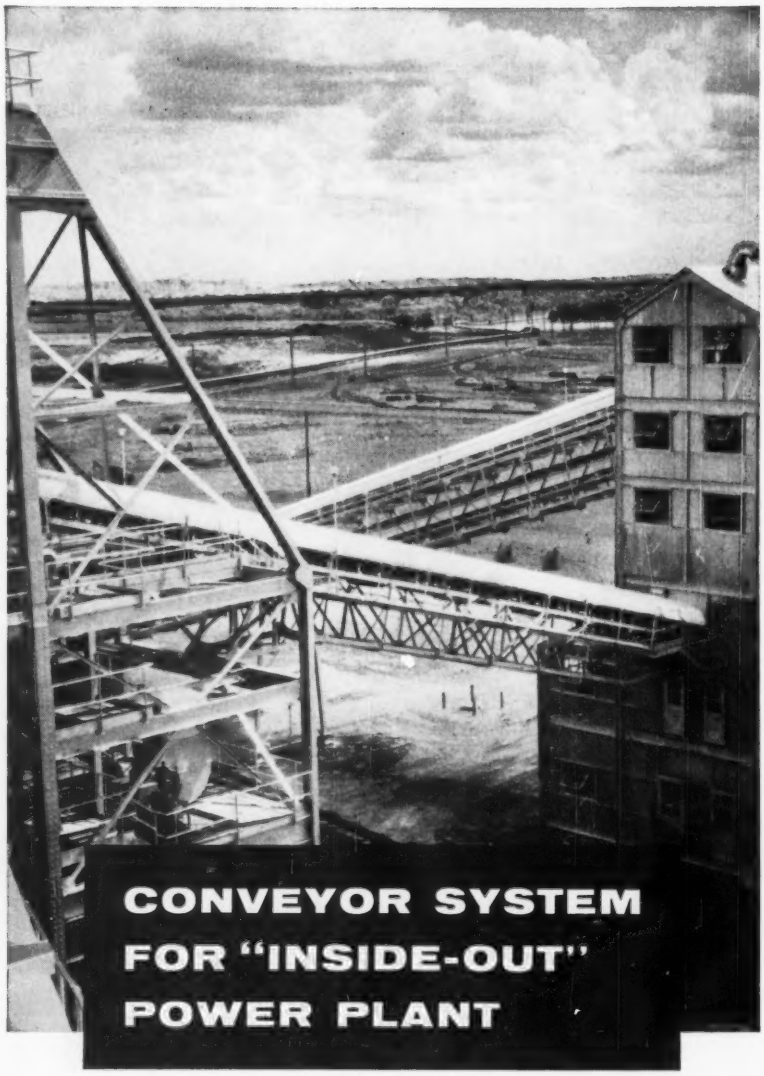

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Free literature

Begins on page 163

36 **Control,** protective equipment is listed in 152-p catalog digest. Contains specs, price lists for switchgear, starters, controls. Square D Co, 6000 Rivard St, Detroit 11, Mich.

37 **Self-locking connectors** are subject of 24-p illustrated catalog. Contains specs, diagrams, wiring information. Avnet Interlock Corp, 8966 National Blvd, Los Angeles 34, Calif.

38 **Unit substation** technical library is title of 7-booklet set GET-2753. Discusses all aspects of substation planning, integration. Lists equipment ratings, includes charts, diagrams and photos. General Electric Co, Schenectady 5, N. Y.

39 **Power distribution** systems for 3- and 4-wire 600-v service are subject of 24-p catalog 10. Includes descriptions of feeder lengths, plugs, connectors. Electric Distribution Products Inc, 2210 31st St SW, Allentown, Pa.

40 **Transistor** power supplies are discussed in illustrated booklet. Includes theory of operation, complete specs. Varo Mfg Co Inc, 2201 Walnut St, Garland, Texas.

Reports from the field

Begins on page 150

Good power economy ups steel profits 7 ways

More efficient production and use of power can tap overlooked profits, steel producers were told at a recent meeting. R W Worley and H G Kitt, in a report titled "Trends in steel mill power plants," detailed seven ways to increase profits: (1) Increase use of available by-product fuels, such as blast-furnace gas which can be used to fire boilers, to cut needless consumption of expensive purchased fuels. (2) Use high-pressure steam systems to power turbo-generators and supply low-pressure requirements. (3) Install modern high-pressure high-capacity blowers to supply more than one blast furnace. (4) Use often-wasted blast-furnace gas to power gas-turbine engine - generators. (5) Conserve cooling water and pumping power by using smaller quantities in winter when lower temperature affords the same cooling ability with less water. (6) Design water-preparation plants for high-efficiency minimum-mainte-

nance boiler operation. (7) Standardize electric-power system frequency at 60 cycles for ease of interconnection with utilities, simplified maintenance and faster delivery of new or replacement equipment.

Producing one ingot ton of steel requires up to 200 kw-hr of electric power. Even small gains in efficiency can produce significant savings, the authors concluded.

Grid system to spur E European power drive

VIENNA, AUSTRIA (McGRAW-HILL WORLD NEWS)—Building of an E European power network to provide direct hookups between the Communist-bloc countries is a major objective of the Com-Econ (Mutual Economic Assistance Council), reports indicate. A recent Moscow meeting discussed plans for a grid system to connect U.S.S.R., Poland, E Germany, Czechoslovakia, Hungary, Bulgaria and Rumania, with direct lines to be laid to Yugoslavia.

Also discussed was a series of projects to utilize Danube River water in run-of-river plants from the Austria-Hungarian border to the Black Sea delta in Rumania. Yugoslavia was among Communist nations represented at the conference.

Calendar of Events

Jan 14-15 — Instrument Society of America, Yankee Instrument Fair & Symposium. Hotel Bradford. Details from ISA, Boston Section Inc, Box 282, Boston 1, Mass.

Jan 27-29—American Society of Heating and Air-Conditioning Engineers Inc, Annual Meeting. Pittsburgh, Pa. Details from ASHAE, 62 Worth St, New York, N. Y.

Jan 27-30 — Plant Maintenance & Engineering Show. International Amphitheatre, Chicago, Ill. Details from Clapp & Poliak, Inc, 341 Madison Ave, New York 17, N. Y.

Jan 29-30 — Armour Research Foundation of Illinois Institute of Technology and **American Welding Society, Chicago Section,** Midwest Welding Conference. Illi-

(*Continued on page 212*)

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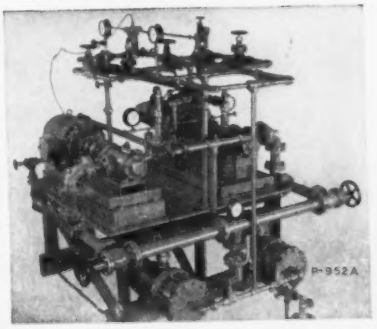

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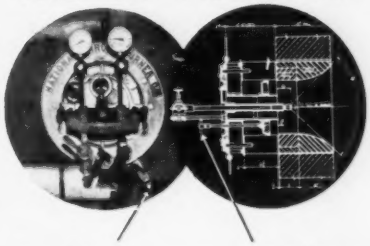

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Another "dual advantage" of NATIONAL AIROIL Universal Registers is that they are equipped for dual fuel firing of gas and oil. Universal Registers with burners are available in three (3) sizes . . . capacities up to 60,000 lbs. of steam produced per burner per hour. Write for Bulletin 51.

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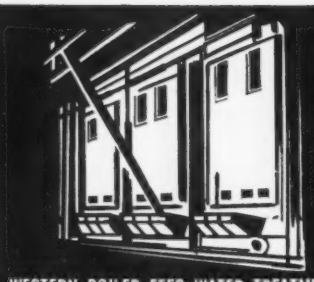

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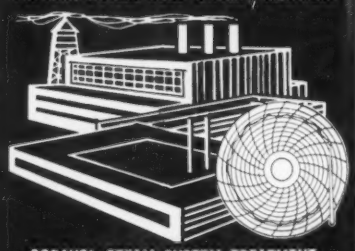
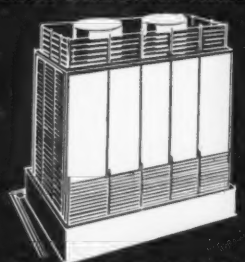


CORAVOL STEAM SYSTEM TREATMENT



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Reports from the field

Begins on page 150

nois Tech Chemistry Bldg, Chicago. Details: Harry Schwartzbart, Armour Research Foundation, 10 W 35th St, Chicago 16, Ill.

Feb 3-7—American Institute of Electrical Engineers, Winter General Meeting. Hotels Statler and Sheraton-McAlpin, New York. Details from AIEE, 29 W 39th St, New York 18, N. Y.

Feb 3-4—Instrument Society of America, National Conference on progress and trends in chemical and petroleum instrumentation. Wilmington, Del. Details from H S Kindler, ISA, 313 6th Ave, Pittsburgh 22, Pa.

Feb 9-15 — National Electrical Week. Purpose: "To enhance public appreciation of electricity and the contributions of the electrical industry to the nation's progress and economy." Details from National Electrical Week Committee, 290 Madison Ave, New York 17, N. Y.

Feb 24-28 — American Institute of Mining, Metallurgical and Petroleum Engineers Inc, Annual Meeting. Jung Hotel, New Orleans, La. Details from AIME, 29 W 39th St, New York 18, N. Y.

Feb 26-28—American Society of Civil Engineers, National Convention. Chicago, Ill. Details from ASCE, 29 W 39th St, New York 18, N. Y.

March 11-13 — Instrument Society of America, Eighth Annual Conference on instrumentation for the iron and steel industry. Roosevelt Hotel, Pittsburgh. Details from Frank K Briggs, Westinghouse Electric Corp, Atomic Power Div, Large, Pa.

March 17-21—National Assn of Corrosion Engineers, 14th Annual Conference. Civic auditorium, San Francisco, Calif. Details from NACE, 1061 M & M Bldg, Houston 2, Texas.

March 17-21 — International Atomic Exposition Inc, in conjunction with **1958 Nuclear Congress,** Atomfair of the Atomic Industrial Forum. International Amphitheatre, Chicago, Ill. Details from

Gray & Rogers, 12 S 12th St, Philadelphia 7, Pa.

March 26-28 — Illinois Institute of Technology, 20th Anniversary Meeting of American Power Conference. Hotel Sherman, Chicago. Details: R A Budenholzer, mechanical engineering dept, IIT, 3300 Federal St, Chicago 16, Ill.

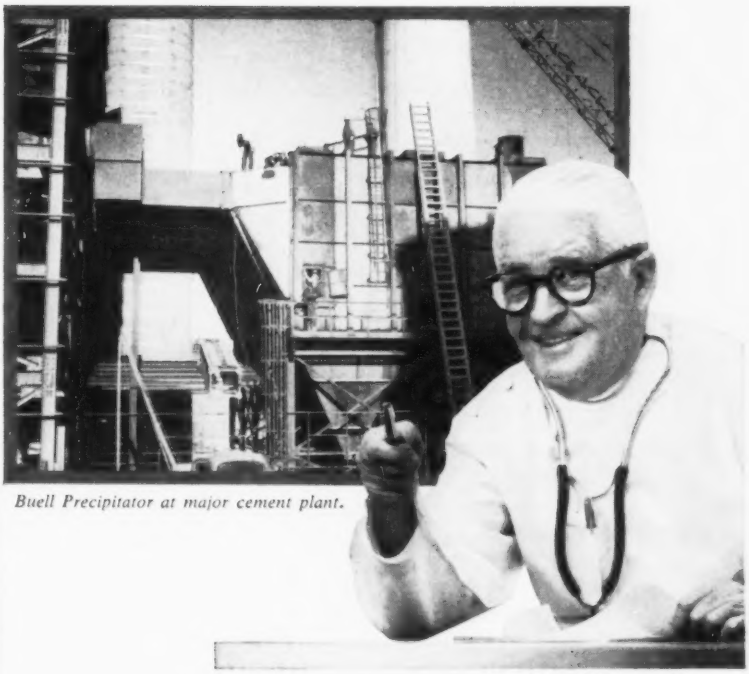
March 27-29 — Electrical Maintenance Conference. Shrine Exposition Hall, Los Angeles, Calif. Details from Fred J Tabery, 3443 S Hill St, Los Angeles, Calif.

March 19-20—American Society of Mechanical Engineers in conjunction with **American Institute of Electrical Engineers,** Engineering Management Conference. Hotel Somerset, Boston, Mass. Details from ASME, 29 W 39th St, New York 18, N. Y.

Engineering societies project joint headquarters

Plans have been announced for a new United Engineering Center. Building, to be located near the United Nations building in New York City, will be headquarters for 16 national engineering societies; will also house largest technical library in the U.S. and possible engineering Hall of Fame.

Fund-raising campaign should collect $5,000,000 from industry, to match $5,000,000 put up by engineering societies. Construction will begin in 1958; building will be occupied by 1960. Twenty-story building will replace present building at 29 w 39th St. (*Continued on p* 214)



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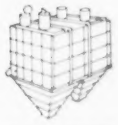

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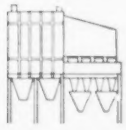

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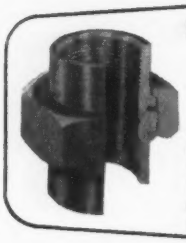

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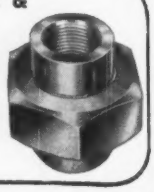

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Reports from the field

Begins on page 150

According to Willis F Thompson, delegate of ASME to United Engineering Trustees, organization in charge of building plans, new center is essential "if the engineering societies are to continue to pace the tremendous growth of the engineering profession in an increasingly technical age."

Founder societies whose headquarters will be in new center are ASCE, AIME, ASME, AIEE, AIChE. Eleven associated societies will also have headquarters in building.

Infrared heating

Continued from page 79

and conduction from floor, wall and machinery surfaces. Workmen don't feel a sharp change in air temperature when they go outside or into unheated areas of the plant. Tools and machinery are always warm to the touch. And system doesn't make drafts, noise or odors.

Infrared heating needs are calculated in sq ft instead of cu ft, so no single yardstick can be used to compare performance with conventional space heaters. As a general guide, gas infrared may lower heating costs by about 20% in buildings easily heated by other methods. In hard-to-heat buildings, heating costs may be reduced up to 50%. In addition, infrared can provide spot heat in warehouses, unheated buildings, loading docks and other partially exposed areas. Generators can be installed at heights from 7 to 60 ft without sacrificing efficiency. Sidewall mounting is also feasible.

Operation. This infrared generator operates on natural, manufactured or liquefied petroleum gas. The gas is metered through an orifice and enters an air-aspirating chamber and a mixing tube. Then it is distributed uniformly through the ceramic mat. Pre-mix or blower is not needed with this 100%-primary air burner.

The generator uses multiples of an eight-ceramic combination called a rayhead. These are grouped in an aluminum reflector to help direct infrared toward the surfaces to be heated. In high-bay buildings a large number of rayheads are combined in a single fixture to radiate over a large area. (*Continued on page* 215)

DEFIES HEAT
ABRASION...
FATIGUE...
LEAKS

FLEXIBLE TUBING FOR THE POWER INDUSTRY

High temperatures and pressures? Exposure to crushing, abrasion, expansion, contraction? Name your operating conditions for air, water, steam lines, for conveying volatiles, gases, chemicals, powder, granular and semi-solid materials. Penflex can meet them with flexible bronze, galvanized and stainless steel corrugated and interlocked tubing. All types, all sizes. 1/8" to 24" I. D. Ask for booklet. Pennsylvania Flexible Metallic Tubing Company, Inc. 7237 Powers Lane, Phila. 42.

PENFLEX
TIGHT AS A PIPE BUT...
FLEXIBLE

Infrared heating

Continued from page 214

Zone thermostats are normally used for heating control. These are shielded from direct rays of the generator so that heat rising from the floor controls the temperature.

Gas infrared heating is used in various types of industrial buildings. Here are some examples:

(1) **Metalworking firm** in Ohio has a 754,000-Btu system (26 infrared generators) in an all-steel building with a 6400-sq-ft concrete floor. It's estimated that space heating would call for a million-Btu system. Heating cost with natural gas for an eight-month period from October 1956 through May 1957 was $1036. This amounts to 16c per sq ft.

(2) **Foundry** in Newark, N. J. heats a 35-ft high-bay building with infrared. In addition, it spot heats another building used for grinding. Fuel cost for spot infrared at this location is about $667 per year compared to $1479 per year for vented gas heaters. Mixed gas (604 Btu per cu ft) is used at 3 in. water-column pressure.

(3) **Steel warehouse** in Louisville, Ky. warms a one-man work station with a portable over-desk gas infrared generator. It gives working comfort in a limited area.

(4) **Manufacturer** in Elyria, Ohio uses 30 overhead infrared generators to heat a 6000-sq-ft Butler building. Even though it opens on two sides into an unheated 1,300,000-sq-ft warehouse and welding shop, personnel are kept comfortably warm.

(5) **Steel products** company in Houston, Texas operates infrared generators three hours a night to keep steel temperature well above the dew point. This prevents corrosion of steel warehouse stocks from moisture condensation during the night when humidity rises to 85%.

(6) **Lakefront dock** in Toledo, Ohio uses gas infrared to speed cold-weather unloading of frozen coal in gondola cars. Tubular gun burners previously used thawed about one car per hr. Gas infrared generators thaw a car in seven minutes.

Niagara Project's Tuscarora plant is to have 12 large reversible pump-turbines built by Allis-Chalmers Mfg Co and S Morgan Smith Co.

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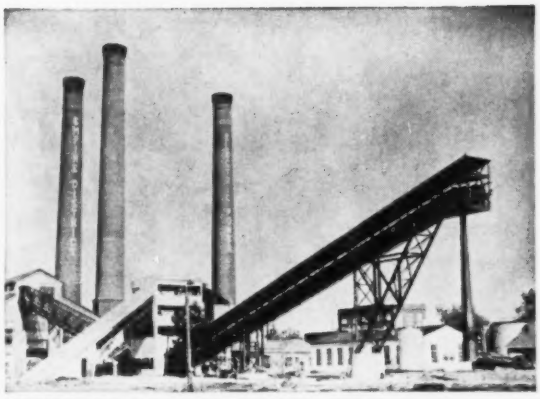
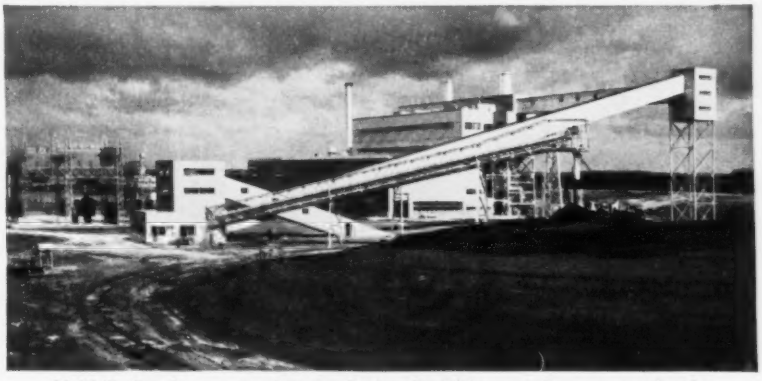


McNally Pittsburg developed this 250 ton per hour system for the EMPIRE DISTRICT POWER & LIGHT CO.



McNally Pittsburg assisted in developing this 300 ton per hour system for the KANSAS POWER & LIGHT CO.

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"Joe, you wouldn't buy the engine of your car from one manufacturer, the wheels from another and the body from still another, would you? Neither would I. And when I design for induced draft, I specify a P-D Stack because the I.D. Fan, though it is important, isn't the whole story. The combined breeching, stack and fan, built as ONE apparatus, gives me unit responsibility, compact design, simplified engineering, and positive performance, with a lot less purchasing details.

"Another thing, I'd rather buy my Dust Collector from the same manufacturer that made my Stack and Fan. For this is all part of the same system for handling the gas after it leaves my boiler unit.

"There's nothing like putting all the responsibility on ONE manufacturer's shoulders if you can, for then you'll come out on the long end nine times out of ten. Buying such equipment piece-meal is antiquated and costly."

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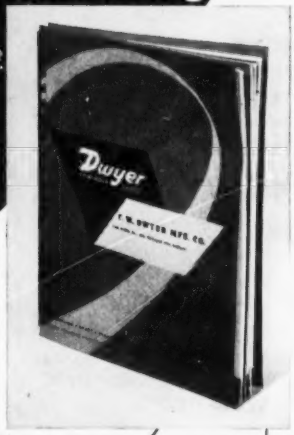

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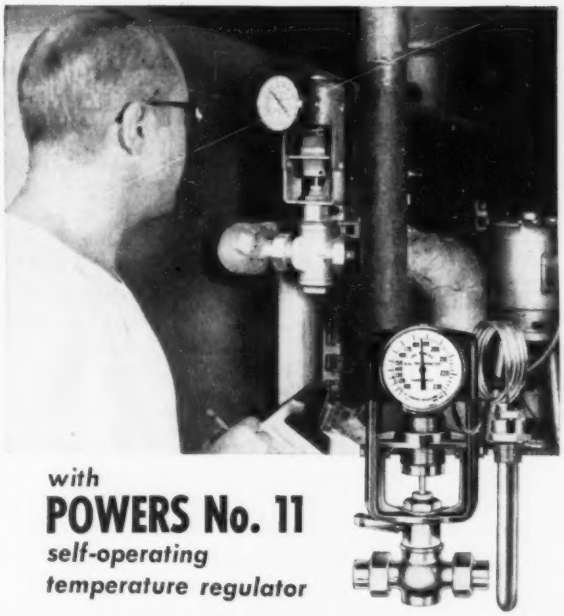

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ENGINEERS

If you have been looking for an Employment Agency that is skilled in the **STATE OF THE ART** of Technical Recruitment and **RELIABILITY OF INFORMATION** concerning positions, why not communicate with us at once! ALL POSITIONS FEE PAID.

FIDELITY PERSONNEL SERVICE
1218 Chestnut St. Phila. 7, Pa.
Specialists in Aviation, Electronics and Nucleonics

REPLIES (Box No..): Address to office nearest you c/o this publication Classified Adv. Div.
NEW YORK: P. O. Box 12 (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

Fuel Specialist—One of the most highly respected names in the utility power field with principal offices in New York City has an opening on its consulting staff for a technically qualified Fuel Specialist. Preferably someone with coal mining engineering background. To the successful applicant, this position offers ample opportunity for professional growth and personal achievement. The man we are seeking must be thoroughly experienced with solid, liquid and gaseous fuels used in large steam electric generating stations. Work includes studies of comparative economics, market potentialities, sources of supply, nature and extent of reserves, production costs, trends in sales price and the negotiation of fuel supply contracts, etc. Some travel involved. We invite you to investigate this opening by forwarding a complete resume to: P-6765, Power.

Assistant Superintendent for municipal Light & Power Department, pop. 20,000. Should be graduate Electrical Engineer with 3 years experience in generation, transmission, distribution and some administration. P-6817, Power.

SELLING OPPORTUNITY OFFERED

Steam Boiler or Generator Distributors with Primary Sales and Service in the medium pressures (30-100 lb.) and Good Experience in steam with clothing, laundry, and dry cleaning industries, wanted to handle sales and service of miniature (¼ H.P. up to 5 H.P.) Electric Steam Generators up to 100 lbs. pressure each unit bearing a Registered National Board of Boiler and P.V.I. Number, individually inspected under the miniature boiler code. Please reply to RW-6528, Power.

POSITIONS WANTED

Chief Draftsman: Graduate M.E. with 15 years piping, structural, mechanical, electrical and concrete drafting experience. PW-6182, Power.

Power man age 30, approx. 12 yrs. exp. in power work. Marine and stationary, operations and maintenance. Technical education. Desires position in So. Arizona or So. California. PW-6646, Power.

Design Engineer, 19 yrs. exp., Mechanical, Industrial, Power Field, seeks position as designer or application engineer. PW-6848, Power.

Wish power plant job, anywhere; B.S. degree in Industrial Arts for KSTC, Pittsburgh, Kan. Experience in pipefitting, electrical and machine shop work; age 46; ICS student. John Radovic, 313 So. Pine, Hamburg, Ark. Phone ID 3-5328.

APPLICATION ENGINEER

Prominent heavy machinery manufacturer, located Midwest, has excellent opportunity for man with at least three years experience in internal combustion engine application engineering as related to fluid flow design of cooling water, lubricating and fuel oil, and air piping in power plants. Must have ability to calculate size of auxiliary pumps, coolers and so forth. Some knowledge of machine design and engineering mathematics essential. Must be able to handle all application engineering required by engine contracts. Write, stating age, experience and salary expected. Replies strictly confidential.

P-6585, POWER, 520 N. Michigan Ave., Chicago 11, Ill.

MECHANICAL DESIGN ENGINEER

Established engineering-construction firm with Chicago and New York offices. This position in Chicago office. Experience required with detailed design supervision of steam-electric stations and industrial plants. Excellent opportunity to become part of expanding progressive company. Send complete resume.

P-6594, POWER
520 N. Michigan Avenue
Chicago 11, Illinois

WANTED FOR EXPORT

USED
DIESEL ELECTRIC GENERATORS
TURBO & HYDRO ELECTRIC GENERATORS
BOILERS
COMPLETE POWER PLANTS
MACHINERY EXPEDITERS
170 B'WAY, N. Y. 38, N. Y.
Our 17th year

WANTED

Complete power plants, turbo generators, Boilers, Condensers, Engine generators, Processing Plants and equipment.

PAUL OBERMAN
1910 Delmar St. Louis, Mo.

WANTED ASSISTANT CHIEF ENGINEER

Graduate Mechanical Engineer, or equivalent, with a minimum of three years experience in high pressure power plant operation. A high caliber man is required in the operation and maintenance of 1250 pound pressure, pulverized fuel fired, steam-electric power plant located in the midwest. Good working conditions and employee benefits.

Write stating education, experience, salary expected, and availability. All replies will be held confidential.

P-6786, POWER
520 N. Michigan Ave., Chicago 11, Ill.

WANTED BOILER

7500 to 8000 Kgs Steam and Pressure 42 Kg or 600 lbs. square inch.

New or Semi New. Immediate Delivery.

W-6795, POWER
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

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For your new surplus motors, controls and transformers!

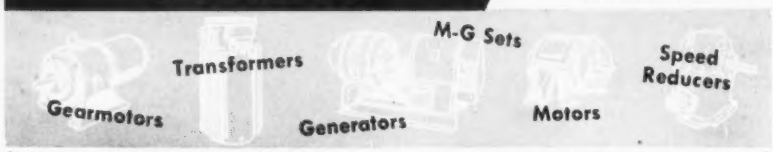
NEW MOTORS AVAILABLE:
Over 5,000 new motors, in stock, from ¼HP to 200 HP. Special low prices.

Write, wire or phone collect!

AJAX ELECTRIC MOTOR CORP.
P.O. Box 262, Rochester, N.Y.
Long Distance Phone LD. 132

CHECK WITH WAGNER FIRST!

Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P. OUR 52nd YEAR



A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
500	Whse.	Slipring	2200	450
450	El. Machy.	Synch.	2300/440	400
400	Whse. (2)	Synch.	2200	1800
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2200	3600
400	Whse.	Sq. Cage	2300	900
400	G.E. (2)	Slipring	440	900
400	G.E.	Slipring	2300	514
350	G.E.	Sq. Cage	2200	1800
350	Cont. b.b.	Slipring	2300	900
350	G.E.	Slipring	440	1200
350	Allis Ch.	Slipring	2200/4000	600
300	G.E.	Slipring	2200/440	600
300	G.E. (2)	Synch.	2200/440	360
300	Whse.	Sq. Cage	2200/440	720
300	Whse.	Synch.	440	1200
300	G.E.	Slipring	440	450
250	L.A. TEFC	Sq. Cage	2300	900
250	G.E.	Sq. Cage	2200/440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E.	Slipring	220/440	720
250	Whse.	Slipring	440	1200
250	G.E.	Sq. Cage	2200	1800
225	G.E.	Synch.	220/440	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Allis Ch.	Slipring	2200/440	720
200	Whse.	Sq. Cage	2200/440	900
200	G.E.	Sq. Cage	440	600
175	G.E. (2)	Synch.	220/440	720
150	G.E. (4)	Slipring	2200/440	600
150	Cr. Wheeler	Sq. Cage	220/440	450
150	G.E.	Slipring	220/440	450
150	G.E. (2)	Sq. Cage	2200/440	1800
150	Allis Ch. b.b.	Sq. Cage	2200/440	720
150	L. Allis b.b.	Sq. Cage	440	3600
125	G.E. TEFC	Sq. Cage	2200	3600
125	Ideal	Slipring	4000/2200	900
125	Allis Ch.	Sq. Cage	2200	900
100	Smith b.b. (6)	Sq. Cage	220/440	1800

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
200	G.E.	RC	600	1150
150	Whse.	SK-184	250	1150
150	Cr. Wh.	CCD	250	650
125	Gen. Elec.	CD	250	1150
100	Allis Ch.	E	125	1200
100	Reliance	651-T	600	1200
75	Gen. Elec.	CD-123	125/250	1200
60	Allis Ch. (3)	E-146	250	1500
60	Ideal	D	125	1150
50	Star b.b.	SQ	250	900
25	Whse.	SK-103	250	1750
20	Ideal	D-405	125	1150

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
200	G.E. dynamom.	TLC-74	250	1150/3500
170	Cr. Wh.	151-H	230	500
150	Whse.	SK-184	230	850
125	G.E.	CD-173	230	575/1150
100	Reliance	651-T	550	1000/1600
100	Elliott b.b. T.E.	JH-FE	230	1150
75	Reliance (3)	985-T	230	450/1200
60	G.E. TEFC b.b.	CD-135	230	1150
50	Century	DN-514	230	1150/1750
50	Gen. Elec.	CD-95	230	1800
50	Star b.b.	SQ-92	230	680
50	G.E.	CD-125	230	400/1200
50	G.E.	RF-16	230	250/1000
40	G.E. (2)	CD-93	230	1750
30	G.E.	CD-113	230	500/1500

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	2300 AC	250 DC
200	Whse.*	220/440 AC	550 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	G.E.	2200/440 AC	600 DC
175	Gen. Elec.	220/440 AC	250 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
100	Gen. Elec.*(2)	220/440 AC	250 DC
75	Gen. Elec.	220/440 AC	250 DC
75	G.E.	220/440 AC	125 DC
60	Allis Ch.	220/440 AC	250 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Cr. Wh. b.b. (2)	220/440 AC	250 DC

Arthur Wagner Co. Certified

MO nroe 6-7409

1435 W. RANDOLPH ST

CHICAGO 7, ILLINOIS

FOR SALE

STEAM BOILERS

2—18000 lbs./Hr. Heine 175 psi, straight tube, oil fired, 1920

3—21000 lbs./Hr. Combustion Engr. 200 psi, Stoker fired, 1938

1—28000 lbs./Hr. B&W Package Type, Oil-Gas fired, 1953

1—35000 lbs./Hr. Combustion Engr. 450 psi, 825° stoker fired, 1950

SURFACE CONDENSER

1—2500 Sq. Ft Westinghouse, 2 Pass, with aux., 1950

AIR COMPRESSORS

2—150 CFM, 125 psi, 40 HP, Ingersoll-Rand, V Drive, 1948

DIRECT CURRENT GENERATORS

1—100 KW, General Electric, 250V, 1200 RPM, 1950

1—250 KW, Westinghouse, 250V, 720 RPM, 1950

1—250 KW, Allis Chalmers, 250V, 1200 RPM, 1935

MOTOR GENERATOR SET

1—25 KW, Westinghouse, 250V DC, 208/120V AC, 1800 RPM, 1950

DIRECT CURRENT TURBINE GENERATORS

1—100 KW Westinghouse Non-Condensing, 250V DC, 400 lbs., 1950

1—250 KW Allis Chalmers-Murray, Cond., 250V DC, 165 lbs., 1935

WATER PUMPS

1—14000 GPM @, 370' Hd. De Laval Centrifugal, 690 RPM, 1800 HP, 1920

1—20800 GPM @, 370' Hd. De Laval Centrifugal, 720 RPM, 2500 HP, 1949

1—24500 GPM @, 370' Hd. Worthington Centrifugal, 950 RPM, 3200 HP, 1954

STEAM TURBINES

1—1800 HP, De Laval Condensing, 165 lbs. psi 3600/690 RPM, 1920

1—2500 HP, De Laval Condensing, 400 lbs. psi 3600/720 RPM, 1949

1—3200 HP, Worthington Condensing, 175 lbs. psi 3600/950 RPM, 1954

BOILER FEED PUMPS

1—500 GPM @, 450' Hd. De Laval Centrifugal, 1750 RPM, 100 HP, 1950

1—88 GPM @, 1210' Hd. De Laval Centrifugal, 3600 RPM, 400 PSI, 1950

INTERNATIONAL POWER MACHINERY CO.

1612 Union Commerce Bldg.

Cleveland 14, Ohio **Main 1-9514**

BOILERS

BOUGHT • SOLD • RENTED

1—202 H.P. 150 lb. Keeler Scotch

1—165 H.P. 15 lb. Titusville Scotch

1—200 H.P. 250 lb. Walsh-Widner

1—200 H.P. 15 lb. Cyclotherm #6 Oil

1—300 H.P. 15 lb. Superior #6 Oil

1—200 H.P. 125 lb. Cyclotherm #6 Oil

1—125 H.P. 150 lb. Cyclotherm #6 Oil

6— 90 H.P. 125 lb. Cyclotherm #2 Oil

1— 80 H.P. 250 lb. Cyclotherm #5 Oil

1— 50 H.P. 125 lb. Cl Brooks #2 Oil

1— 50 H.P. 125 lb. Cl Brooks Gas & Oil

1— 50 H.P. 125 lb. Cyclotherm #2 Oil

1— 60 H.P. 15 lb. Cyclotherm #5 Oil

1— 30 H.P. 200 lb. Cyclotherm #2 Oil

BOILER & EQUIPMENT CO.

743 Bedford Ave., Bklyn. 5, N. Y.

UL. 5-3588

NEW STEAM JET AIR EVACTORS

Several in stock, large range in sizes, capacities from 1000 KW to 10,000 KW. Priced right.

CHARLES WEAVER, INC.

19701 James Couzens Hwy.

Detroit 35, Michigan

Phone: BRoadway 3-1900

FOR IMMEDIATE SALE

Cooling Tower 500 GPM from 108°F to 85°F at 70°F wet bulb. Mechanical Tower with fan, 220V, 60 cy., splash-proof motor.

Contact R. G. KARCH, Utilities Superintendent, Buildings & Properties Department, Cornell University, Ithaca, New York.

TURBO-GENERATORS

3000 KW Whse. Cond. 3/60/2400 V. 3600 PM 400 PSIG 750°

2000 KW Al. Ch. Cond. 3/60/600 V. 3600 RPM 400 PSIG 750°

2000 KW Whse. Cond. 3/60/2400/4150 3600 RPM 240/400 PSIG 750°

1500 KW Ell. Cond. 3/60/2400/4150 3600 RPM 400 PSIG 750°

300 KW G.E. Non-C. 3/60/480 V. 3600 RPM 150 PSIG 5# BP

3460 Ft. Surface Condenser

BREW, WOLTMAN & CO., INC.

50 Church St., New York 7, N. Y.

FOR SALE

18 NEW TURBINES

4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

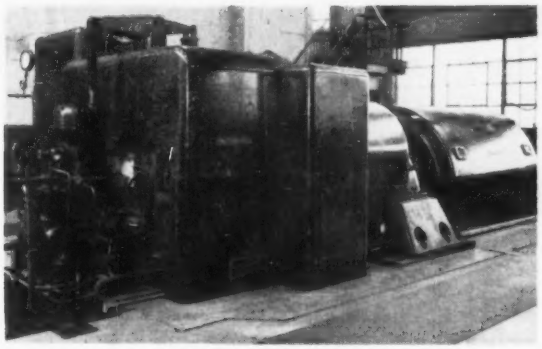
G. M. DeROSE

2457 WOODWARD AVE.

706 DONOVAN BLDG.

DETROIT 1, MICH.

FOR SALE: MODERN 7500 K.W., 650 POUND TURBO-GENERATOR



ACTUAL PHOTOGRAPH

This unit was placed in service in 1949 and has been constantly maintained in excellent condition. Turbine is designed for 650 P.S.I.G., 725° F.T.T. and has automatic extraction at 125 P.S.I.G. Generator is 7500 K.W., 9375 K.V.A. 80% P.F., 6900 Volt, 3 phase, 60 cycle.

Unit is complete with modern switchboard, surface condenser, and all auxiliaries.

BELYEA CO., INC.

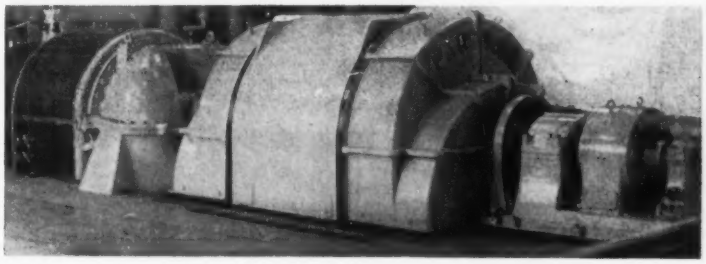
43 HOWELL STREET • Phone: OLdfield 3-3334 • JERSEY CITY 6, N. Y.

TRANSFORMERS

3—833 KVA, 1/60/34500-460 Moloney OISC with taps
2—250 KVA, 1/60/2400-240/480 Moloney OISC, type YC, with taps
1—300 KVA, 3/60/4160-240 Wagner, ITE type HPE Unit Substation, Outdoor.
1—200 KVA 3/60/4160-240 Wagner, ITE type RPB Unit Substation, Outdoor.
1—225 KVA 3/60/440-208Y/120, Moloney Dry type.
3—100 KVA, 1/60/2400-240/120 Whse, Dry Hypersil, with taps.

CASH
For Surplus Electrical Equipment
BENSON-WILIMZIG, INC.
1708 North 8th St., St. Louis 6, Mo.
Phone GArfield 1-4290

8000 KW PACKAGE UNIT



Consisting of 8000 KW, 3600 RPM, 11,500 Volt 3 Phase, 60 Cycle, 450 PSI Parsons Steam Turbo Generator complete with all auxiliaries, modern switch gear and transformers. 90,000 lb. per hour, 450 PSI, Babcock and Wilcox Boiler complete with all auxiliaries. Plant was used as stand-by and is in new condition. Can be inspected any time. *Immediate delivery.*

GENERAL MACHINERY LIMITED
GRANVILLE ISLAND • PACIFIC 3487 • VANCOUVER, B. C.

500 KW PANEL BOARD

GENERATION CONTROL—UNUSED
220 VOLT A.C. OPERATION

Meters — circuit breaker — transfer switches — rheostat — disconnect switch — voltage regulator — reverse current relay. Free standing dead front modern type. Necessary components for parallel operations.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. CUrtis 7-5050

Buying
Good USED Equipment
is frequently the difference between having needed equipment or doing without it.

DIESEL ENGINES — POWER MACHINERY

100 KW to 1500 KW
Diesel Generator Sets • Stationary • Portable • Mobile Motors and Generators

A. G. SCHOONMAKER COMPANY, INC.
MAIN OFFICE: Box 516, Sausalito, Calif. Sausalito 1600
BRANCH: 50 Church St., N. Y. 7, N. Y. Digby 9-4350

BELYEA-RE-NU-BILT
LARGE ELEC. POWER EQUIPMENT
SELECTED STOCK ITEMS

RE-NU-BILT—GUARANTEED—RE-NU-BILT
COMBINATION MILL DRIVES—
D.C. MOTORS WITH M.G. SETS & CONTROLS
PACKAGE DRIVES IN STOCK

1—2250 HP Elliott 300 V, 200/300 RPM DC Motor with 2400 KW GE MG Set. 300 V. DC 2300/4600 V, 450 RPM 3 ph. 60 cy.
1—1375 H.P. G.E., MCF, 415 V. 1300 RPM D.C. motor with 1100 KW G.E. MG Set 415 V. DC, 2300/4000 V. 720 RPM 3 ph 60 cycle.
1—1200 HP G.E. MPC, 600 V, D.C. Motor, 450 RPM, and 1000 KW, G.E. M-G Set, 600 volt DC with 1400 KP, .8 PF, Synch. Motor 13200/6600 volt, 3 ph. 60 cy.

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	HP	Make	Type	Volts	Speed
1	1750	G.E.	M-379BS	4800/2400	1800
1	1500	G.E.	MT	6900	1187
1	1100	F.M. BB	SF8068	4800/2400	1800
1	800	Whse.	CW	550	1776
1	750	G.E.	MT-573	2200	1190
1	700	Al. Ch.	D.P.	2300	500
1	600	Whse.	CW-432D-15	440	1778
1	500	Whse.	CW	550	350
1	350	Cr. Wh.	SIZE-71SR	208/406	1765
1	350	G.E.	IM-17A	440/2200	720
1	350	Whse.	CW-1039C C-15	440	720
1	250	G.E.	MT-424Y	4000	257
1	250	Cr. Wh.	SIZE-290	2300	350
1	250	A.C.		550	600
1	200	G.E.	IM	2200	580
2	200	G.E.	IM	2200	435
1	200	G.E.	MT-557Y	2200	1760
2	200	Whse.	CW-890	2300	1775

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
1	500	G.E.	FT-559AY	2300	3600
1	550	Whse.	CS-1115	2300	900
4	500	Whse.	CS-1216	2200	500
2	450	Whse.	CS-1420	2300/4150	864
2	400	Whse.	CS-7151-610H	6600/4000	3565
1	400	G.E.	1K	2200	500
2	200	G.E.	KT-557	440	1800
2	200/150	Whse.	CS-963H	2300	1175/878
1	200	Whse.	CS-1002	2300/440	450
1	150	Whse.	CS	440	580
1	150	G.E.	IK-15A	2300	860

SYNCHRONOUS

1	7000	G.E.	ATI	2240/6600	600
1	4350	C.W.	3501-SL	13800/6900	514
1	3500	G.E.	TS-6487P	4600/2300/4000	360
2	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2100/1750	G.E.	514	250/350	2300/4600
1	2000	G.E.	514	600	2300/4600
1	1500	G.E.	720	600	6600/13200
1	1000	G.E.	900	260	6600
2	1000	G.E.	720	600	6600/13200
1	750	G.E.	720	275	6600/13200
1	750	G.E.	720	125/250	2300/4600
1	500	Whse.	900	125/250	440
1	350	G.E.	900	125	440/2300/4160
2	300	G.E.	1200	250	2300
1	250	Whse.	1200	275	2300
1	200	El Mby	1200	250	2300/4600
1	300	Whse.	1200	600	2300
1	200	Whse.		550	2300
1	200	G.E.	1200	250	550/3300
1	200	Cr. Wh.	1200	250	440
1	150	Whse.	1200	275	2300
1	100	G.E.	1200	250	4160/2400

TRANSFORMERS

Qu.	KVA	Make	Type	PH.	Voltages
3	3333	Whse.	OISC	1	13800x2300
1	1500	G.E.	PYRANOL	3 auto	4000/4200/4400
3	1000	G.E.	OISC	1	13800x460
2	750	G.E.	FUR	1	4800x35/55
3	500	KUHL	OISC	1	13800x6000
1	225	Marcus	Air	3 auto	208/220
3	100	G.E.	OISC	1	22900x2400/4160Y
3	100	Whse.	OISC	1	4600x460/230/115

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltage
1	5000	G.E.	60/50/60	660/11000/6600
2	2500	G.E.	25 cy/62.5	2300/2300
1	500	Al. Ch.	25/60	11000/2300
1	200	G.E.	60/3000	440/880

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	10000	Whse.	Condensing 650 lbs. 750° F.T.T. Surface Condenser Dir. Conn. Exciter
2	3375	G.E.	650 lbs., 725° FTT, 150 lbs. G.B.P. non-condensing
1	2000	Al. Ch.	175 lbs., 5/30 lbs. G.B.P., non-condensing 3/60/480 volts.

BELYEA COMPANY INC.
43 Howell St., Jersey City 6, N. J.

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	440	Whse.	514
400(2)	2300	G.E.	900
400	4000/2300	Whse.	720
350	4000/2300	G.E.	720
300	2200	G.E.	450
300	4000/2300	G.E.	720
300	2300	G.E.	900
300	440	G.E. (hoist)	600
300	440	Whse.	3600
225	4000/2300	G.E. (hoist)	600
200	2300	G.E.	600
200	2200/440	G.E.	720
150	220/440	Whse.	720
125	2300	G.E.	600
100	440/220	G.E.	720

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G.E.	ATI	720
375	2200	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G.E.	TS	720
300	2200/440	G.E.	TS	1200
150	440/220	G.E.	TS	720
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
500	2200/4000	Elliott	SC	1800
350	2300/440	G.E.	IE-K	1200
300(2)	2200	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
250	440/220	G.E.	KT	720
200	440/220	G.E.	KT	1800
200	2200	G.E.	KT	1800
200	440/220	G.E.	KT	720
200	2200/440	G.E.	IE-K	1200
150	440	Whse.	X-prf.	3600
150	2200	Al. Chal.	AR	1800
150	440/220	G.E.	KT	720
150	2200/440		KT	600
150	2200/440	G.E.	FT	1200
125(2)	2200/440	Whse.	X-proof	720
125	2200/440	G.E.	K	600
100(2)	4000/2300	L. Allis	OX	1200
75	2300/440	Whse.	TEFC	1200

A. C. GENERATORS

1—320 kva, 680 rpm, 2300/440/220 V., G.E.
1—360 kva, 900 rpm, 2200 V., Whse.
1—225 kva, 60 rpm, 220/440 V., G.E.
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

9—1600 amp ITE, 3 pole, 600 V.
6—FKB-155-28, 600 amp., 15,000 V, G.E.
1—400 Amp., Oredit, 3F, 25 KV outdoor
1—400 Amp. R. Smith, 3 P 7.5 KV outdoor

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	1800
200	230	Cr. Wh.	CMC	1200
150	230	El. Dyn.	B/brg.	600
125	230	G.E.	CD	850

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	440	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
125	G.E.	440	Sq. Ca.	250/125
100	G.E.	2200/440	Syn.	250
75	Cr. Wh.	440/220	Sq. Ca.	240/120
65	G.E.	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—500 kva, Al. Ch., 2400/4160Y—600 volts, 3 ph
3—500 kva, G.E., 13,800—300 V.
3—333 kva, G.E., 13,800—2300 V.
2—300 kva, G.E., 4150—240 V., 3 ph., Pyr.
1—200 kva, Al. Ch., 6900—220 V., 3 ph.
3—200 kva, Whse., 4600/2300—230/115 V.
1—200 kva, G.E., 2400—120/240 V., Pyr.
3—200 kva, Mol., 13,800—2300 V.
3—150 kva, Al. Ch. 2400—220 V.
3—150 kva, Al. Ch. 440-220 V., dry New
3—150 kva, G.E., 13,200—2300 V.
3—100 kva, G.E., 2400—120/240 V., Pyr.
6—50 kva, G.E., 13800—120/240 V.

only partial listing

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HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

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SPECIAL OFFERINGS

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1—3000 KW — 13,200 V — N. C. 425# — 170 Ext.—50# BP
1—3000 KW—4150 V 350# Cond.
2—2000 KW—6600 V—N. C. 625#—155# BP
1—1000 KW—240/480 V—Cond. 130/250#—Ext. #15
2—750 KW—250 V—DC—N. C. 250#—25# BP
1—300 KW—480 V—Cond. 210#—Ext. 40#
1—250 KW—240/480 V — N. C. 130# — 10/15# BP

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1—25 Ton—50 Ft. Boom.

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Designed for T2-SE-A2

Now being removed at Philadelphia, Pa., from the S.S. Mission San Francisco.

Complete with deaerating feed heaters, Coffin feed pumps, oil pumps, 1st, 2nd & 3rd stage heaters. Evaporation: normal 43,000 lbs.; max. 60,000 lbs. Designed boiler pressure 700 P.S.I. Final steam temp. at superheater outlet 825° normal. Superheat safety valve setting 624 P.S.I. Boiler heating surface including water wall 6350 sq. ft. Total water heating surface 8030 sq. ft. Economizer heating surface 1680 sq. ft. Operating pressure superheater outlet 600 P.S.I. Furnace volume 573 cu ft. Evaporation rate from and at 212 F lbs/hr/sq ft of total boiler heating surface: Normal 8.33—max. 11.74. Water wall heating surface 118 sq ft. Feed water temp 240 F. Immediate delivery. Presently on barge at Philadelphia. Dimensions: 19'8" high over drum flange: 14' 9-5/16" over casing plate; 16' wide over drum.

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2812 KVA DIESEL GENERATOR UNIT

2812 KVA Crocker Wheeler generator, 3 phase, 60 cycle, 12,000/6900/4160/2400 volts direct connected to 3000 HP Busch-Sulzer (Nordberg) diesel engine, 10 cylinders, 240 RPM, complete with auxiliaries as in operation.

Used only 5 years—Excellent condition

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435 KW General Motors Quad portable diesel generator. 650 HP. Skid mounted, radiator cooled. Westinghouse 3/60/2300 generator, complete, used 60 days.

Fairbanks Morse 1600 HP Model OP, 720 RPM, 1136 KW, F.M. 3/60/2400 generators. Four units available. Portable, skid mounted, with cooling system.

Complete plant installation with all accessories. Priced attractively.

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GUARANTEED REBUILT POWER EQUIPMENT

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
2500	*G.E.	MT (Mill Type)	257
1100	*G.E.	MT	720
1000	*G.E.	M-575-S	1200
1000	*West.	CW	450
600	*G.E.	M-6345-S	1800
500	G.E.	M-6345	1200
400	*G.E.	MTP-565	1200
350	*Al-Ch	ARYW	1800
300	Cr-Wh	SR-70-R	1800
250	Al-Ch	ARY-626	1800
250	*G.E.	I-M-17A	720
200	G.E.	I-M-16	600
200	*West.	CW1950A	514
150	Cr-Wh	SR-50R	1800
150	G.E.	I-M-15A	600
125	G.E.	I-M-15A	600
100	G.E.	I-E-13A	1800
100	G.E.	MT-558	720
100	G.E.	I-M-15A	425
75	West.	CW-770	1200
75	G.E.	MT-347	1200
75	G.E.	MT-356	900
75	G.E.	MT-352	720
75	G.E.	I-M-10	600
60	G.E.	MT-536	1200
60	*West.	CW-762C	900
50	*G.E.	MT-536	1200
50	Al-Ch	ARY-223	900
50	West	CW-758	720
50	Al-Ch	ANY-26	600
40	G.E.	MT-532	1200
40	G.E.	MT-336	900

HUNDREDS OF SLIP RINGS OF SMALL SIZES—ALL SPEEDS

SLIP RING MOTORS

Crane & Hoist Service
3 phase, 60 cycle, 220 or 440 volts

H.P.	MAKE	TYPE	SPEED
100	G.E.	MTC-5546	900
80	G.E.	MTC-5552	600
75	West.	CI-756A	600
50	G.E.	HK	600
35	G.E.	MTC-5536	600
25	West.	CI-636A	720

M.G. SETS

K.W.	MAKE	A.C.	D.C.
1200	Al-Ch	4160	600
1000	West.	4160	250
500	West.	440	220/110
400	Al-Ch	2300	240/120
300	West.	2300	250
250	G.E.	440	250
200	West	2300/4000	250
200	G.E.	2300	250/275
200	Rdgwy	2300	250
150	Al-Ch	2300	250/275
150	G.E.	440	257/275
150	West.	2300/440	250/125
125	G.E.	5000	250
125	West.	2300	250
125	C.W.	4160	125
100	G.E.	2300	250
100	G.E.	2300/4000	250/275
100	West	2300/4000	250/275
100	E.M.	220/440	125
90	G.E.	220/440	125
60	G.E.	220/440	250
50	Reliance	220/440	250

SQUIRREL CAGE MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
1750	*G.E.	K	3600
1750	*G.E.	K	1800
1250	*Al-Ch.	ANX	3600
600	West	CS	720
600	*G.E.	K-63455	1200
500	*G.E.	K-63455	1200
500	*G.E.	I-13-E	900
350	*G.E.	KT-558-A	1800
300	*G.E.	K-6344	1200
250	*West (TE)	CS-81205	1800
250	*G.E.	KT-599-S	1800
250	*West	CS-875-S	1800
250	Brook	RS-28	1200
200	*G.E.	FT-549	3600
200	*G.E.	I-K-13B	1800
200	West	CSP-581-S	1800
200	Brook	RS-27	1200
200	*West	CS-930-A	900
200	G.E.	KT-564-S	720
200	*Al-Ch	AN-37-G	720
200	*West	CS-1010	600
200	Al-Ch	ARW-631	600
150	Cr-Wh	SC-149	3600
150	Al-Ch	AN-30-F	1200
150	West	CSP-5815	1200
150	G.E.	I-K-15A	900
150	*West	CS	600
125	Al-Ch	AR-226	1800
125	Cr-Wh	5-Q	1200
125	G.E.	K-558	900
100	*West (TE)	CS-507-S	3600
100	G.E.	FT-542-Z	1800
100	Al-Ch (TE)	ARZ-826	1200
100	Al-Ch	AW-23-D	1200
100	G.E.	KT-556	900
75	Al-Ch	AR-445	3600

SPECIAL NEW WESTINGHOUSE

Single Step. Primary resistance magnetic Squirrel Cage Motor Starters 3/60/—Class 11-400 Size 5

QUA.	HP	PRICE
10	100	$1075.00
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SAVE 40%

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1875 KVA WORTHINGTON MOORE TURBINE 400 PSI, 700°F Condensing, driving 2300 Volt CROCKER WHEELER GENERATOR 25000#/Hr 450 PSI, 738°F, Coal Fired BOILER; includes all auxiliaries, controls, 25 Ton powerhouse crane and coil handling facilities.

(Will sell boiler or generator set separately)

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400 HP B.&W. (Sterling) 160 PSI Oil/Gas fired, ASME, New 1947. (2)
Comb. Engrs. M-2 Package 175 HP—275 PSI oil fired (3)

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GENERATOR SETS

500 KVA RATHBUN JONES Gas Engine Set 3/60/2300V
540 KW WESTINGHOUSE—DC—120/240 Volts Steam Turbine 200 PSI
125 KW G.E. 2300 V 3/60/514 RPM WORTHINGTON Gas Engine 5 KW Exciter and Panelboard

TRANSFORMERS

2000 KVA 13000 200/120 V FURNACE (3)
750 KVA 12000/45-60 1 ph. 25 cy. (1)
250 KVA 2400/480 1 ph. 60 cy. (3)
75 KVA 4600/115-230 1 ph. 60 cy. (3)

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TRANSFORMERS—60 CYCLE

Qu	KVA	Make	Type	Phase	Voltages
2	3000	Maloney	TCR	3	7200/**13800**-4160/2400
2	750	G.E.	K	1	**4600-120/240**
1	750	G.E.	HT	3	4150Y-208/416
3	500	West.	SL		4800/2400-240/480
1	300	Penna.	(Askarel)	3	60-12470Y/7200-240
2	250	G.E.	H Pyranol	1	2400-4800-8320Y **120/240**
2	250	West.		1	2300/**4600-230/460**
3	200	G.E.	H	1	7800-15600-220/440
1	150	Elsler	OA	1	4160-240/480
3	100	G.E.	H, Form W28		2400/4160-240/480
5	50	G.E.	ES	1	60-2400/4610-240/480
4	25	West.	Hypersil	1	2400/4160-120/240
3	15	West.	H Pyranol	1	6900/11950Y-120/240
1	50	Amer.	Asbestol	3	4160-120/208Y

SYNCHRONOUS MOTORS

Qu	HP	Make	Speed	Type	Volts
1	100	G.E.	900	TS	2300
1	**125**	**G.E.**	**600**	TS	2300
1	**138**	**F.M.**	**900**		4800
1	150	G.E.	1800	TS	220/440
2	150	Allis-Ch.	360		2200
1	150	West.	900		220
1	300	Elec. Mch	720	TEFC	2300
1	500	West.	450	HR	440
1	1000	West.	360	Mill	2300/4150

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
2	40	West.	690	CW	220/440
1	60	G.E.	1800	MT	220
1	75	G.E.	600	IM	440
2	100	West.	1800	T.E.F.C. B.B.	220
1	150	G.E. Triclad	1175	M	220/440
3	150	Allis-Ch.	1800	AY-RW	2300
1	200	West.	514	CW	440
1	250	West	300	CW	440
1	350	West.	1800	CW	2300
1	500	G.E.	450	MT	2200

SQUIRREL CAGE

Qu	HP	Make	Speed	Type	Volts
1	25	G.E.	1170	405TEFC	220/440
1	50	G.E.	1200	Tri Clad	220/440
2	75	West.	1180	CS-607	440
1	100	G.E. 543	1775	KTP	220/440
1	150	G.E.	720	KT-562	440
2	200	Cont.	1800	Exp. Proof	220/440
2	250	G.E.	1790	K.T.E.F.C.	2300
1	275	G.E.	1200	KT559RS	2200
1	300	G.E.	1800	K-4150V	new
1	400	Cont.	1200	N806S	2300

MOTOR GENERATOR SETS

Qu	K.W.	Make	Speed	DC	AC
3	60	E.M.	1200	125	220 v. Syn.
2	100	West.	1200	250	2300/4150Y Syn.
1	150	Cr. Wh.	600	125	220/440
1	175	West.	1200	125	4150 Syn.
1	300	G.E.	1200	250	2300/4160Y S.R.
1	1000	West.	720	600	2300/4160Y

D.C. 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
2	50	Cr. Wh.	700	CM-50H, 220V
1	75	C.W.	900	WP T.E.F.C.
1	150	C.W.	900	WP T.E.F.C.
1	250	Allis Ch.	1750	FBL 149BB

A.C. HOIST MOTORS

Qu	HP	Make	Type	Speed	Volts
1	35	G.E.	MTC	585	440
2	300	G.E.	ITC-5017	600	440

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HP	Make	Type	Speed
400	West. B.B. Drip.	CSP-681S	1800
400	West. S.B. Open	CS	900
350	A.C. S.S. Drip	ARWW-626	3600
300	G.E. S.B. Open	IK	1800
300	A.C. S.B. Open	AR-630	1800
300	G.E. S.B. Open	IK	900
300	G.E. S.B. Open	IK	720
300	West. S.B. Open	CS-1002	600
250	G.E. TEBB, 2300 V	K	1800
250	G.E. S.B. Open	KT	1800
250	F.M. B.B. Open	H	1800
250	L.A. B.B. Drip	OGX	1800
250	G.E. S.B. Open 2200 v	IK-16	1200
250	G.E. S.B. Open	IK	1200
250	G.E. S.B. Open	IK	900
250	G.E. S.B. Open	IK	720
200	G.E. S.B. Drip	K-6326	3600
200	F.M. B.B. Open	H-207	1800
200	G.E. TEBB	K	1800
200	A.C. S.B. Open	ARW-626	1800
200	G.E. S.B. Open	AT-558	1800
200	Cont. T.E.F.C. B.B.		1800
200	GE. S.B. Open	IK-15	1200
200	G.E. S.B. Open	IK-15S	1200
200	G.E. S.B. Open	KT-562	1200
200	G.E. S.B. Open 2200V	IK	1200
200	L.A. T.E.F.C. B.B.	JX-137	1200
200	G.E. S.B. Open	IK	900
150	G.E. TEFCBB	K-6328	3600
150	G.E. TEFCB XP	K	3600
150	L.A. B.B. Open	OGX-107	1800
150	G.E. TEBB	K	1800
150	West S.B. Open 220 V	CS	1800
150	G.E. S.B. Open	IK	1800
150	West. S.S.B. Open	CS-772C	1200
150	G.E. S.B. Open	KT-558	900
150	Cont. T.E.F.C. B.B. New		900
150	G.E. B.B. Open	KT-558	900
150	G.E. S.B. Open	IK	720
150	Howell BB Open		720
125	G.E. TEFCBB	K	3600
125	West. S.S.B. Open	CS-761C	1800
125	West. S.S.B. Open New	CS-607	1800
125	G.E. S.B. Drip	K-505	1800
125	G.E. S.B. Open	IK	1800
125	West. S.S.B. Open 2200 V	CS-607	1800
125	Wes. S.S.B. Open	CS-716C	1800
125	G.E. S.B. Open	KT-553	1200
125	G.E. S.B. Open	IK	1200
125	West. SSB Open	CS-764C	1200
125	G.E. S.B. Open	IK	900
125	G.E. S.B. Open	IK	720
125	G.E. S.B. Open	IK	600
100	A.C. B.B. Open	AR-423	3600
100	A.C. S.B. Open	AR-505S	3600
100	Reliance B.B. Open	AA-504	3600
100	G.E. S.B. Open	KT-343	1800
100	A.C. S.B. Open 2200 V	ARX	1800
100	G.E. S.B. Open	KT-347	1200
100	West. SSB Open	CS-607	1200
100	West. SSB Open	CS	1200
100	A.C. SB Open 2200 Volt	ARX	1800
100	G.E. S.B. Opes	IK	900
100	G.E. S.B. Open	IK	720

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3 New Worthington Surface Condensers—11000 sq. ft. each—single pass—Monel water boxes—Cupro-Nickel tubes & tube sheets. Tubes $\frac{5}{8}$" O.D. CAPACITY: lbs/hr—70,000; circulating water 14180; circulating water connections 30"; operating weight 86,000 lbs; overall length approx. 21'; width & height 9'4". Built for U.S. Navy. Designed for low head room.

8900 SQ. FT. UNITS

1 New unit by C. H. Wheeler. Test pressure: shell 30 lbs; water box 30 lbs.—single pass. Turbine steam exhaust inlet 6' $1\frac{3}{4}$" x 10' 2". Overall width 12' $2\frac{1}{4}$"; overall length 14' $10\frac{3}{4}$"; overall height 5'7". Water inlet 36" x 30" outlet. Monel heads and water boxes; Cupro-Nickel tubes. Built for U.S. Navy of very best materials.

1135 SQ. FT. UNITS

2 New Units by C. H. Wheeler. 2-pass—shell 30 PSI—tubes, chest 30 PSI: DIMENSIONS: 42" diam.—12' long. 24" exhaust steam inlet—water box inlet & outlet 10". 9300 lbs./hr. steam capacity; 1175 GPM circulating water. Complete with twin air ejectors type 4H Wheeler with inner cooler. Built originally for Navy.

580 SQ. FT. UNITS

6 New units—Capacity: 4300 lbs/hr on 28.5 vacuum. 8" water inlet & outlet—18" steam inlet. 2 pass— complete with air ejectors.

3 LIBERTY SHIP TYPE UNITS

2700 Sq. Ft.—2-pass type.

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28,000 pounds steam per hour Babcock & Wilcox Package Boiler, type FM9, size 61, integral furnace, 175# steam pressure, oil or gas fired, mounted on steel skids, complete with automatic control.

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Furnace Vol: boiler 310 cu. ft., superh. 247 cu. ft.

60,000 Lbs.

10 Babcock Wilcox
3 Foster Wheeler
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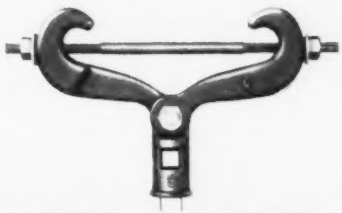

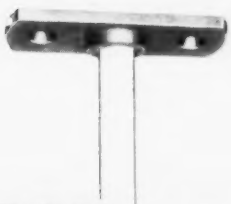

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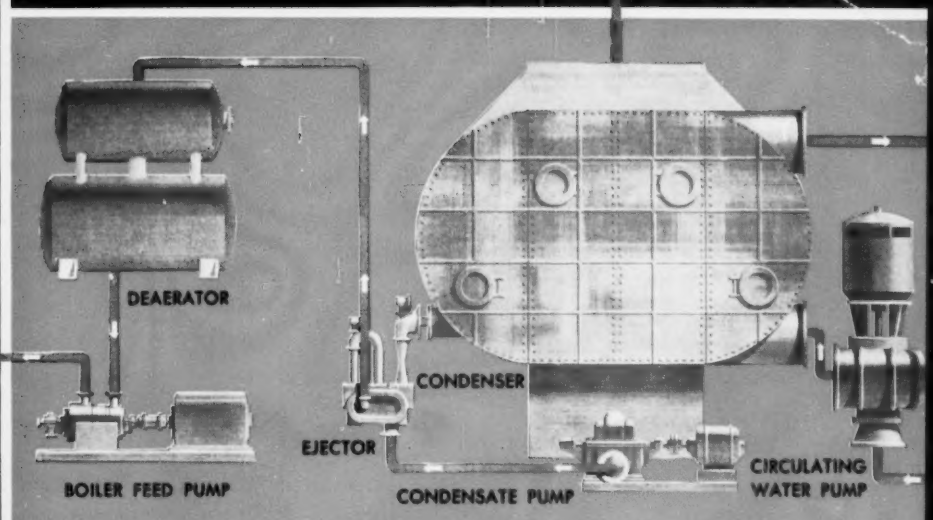

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